POWER

Established 1884—McGraw-Hill Publishing Company, Inc.
PHILIP W. SWAIN, *Editor*

May, 1934 Volume 78, Number 5

LONG ROW TO HOE

• ANOTHER SMOKE INVESTIGATION HAS ENDED. With C.W.A. funds to the extent of $70,000, Chicago has just completed perhaps the most extensive smoke campaign and investigation ever conducted in this country.

• WHAT OF IT? Well, the investigation was undoubtedly warranted, in these times, from the employment angle alone. Granted, but was any great progress made toward a solution of the smoke problem? Not much, unless it be progress to learn what can't be done.

• THIS LATEST IS JUST ANOTHER AND BIGGER DEMONSTRATION that "education" and "drives" won't take you far in smoke prevention. They bring little except some reduction in dense smoke in certain periods and in favored localities.

• STRONGER MEDICINE, IN THE SHAPE OF LEGAL PENALTIES, has been suggested and tried with not much greater success. Two factors enter, one typical municipal politics that carry "insiders" around inconvenient ordinances, the second the practical impossibility of preventing smoke in many cases.

• IT IS ALL VERY WELL to order every smoky stack to "cease and desist" by a certain date, but how will the best of municipal governments face the thousands who will cry "tell us how to do it without throwing ourselves into bankruptcy."

• IMAGINE CARRYING SUCH A LAW to its logical extreme and including the thousands of private homes which make a large part of the smoke in soft-coal-using districts? Impossible! The very most one can hope for is a minimum equipment requirement for new domestic installations—a long-time process, partly effective.

• FINALLY IT IS NO LONGER PRACTICABLE to think only of black smoke, forgetting the equally objectionable dust and fly-ash. These are not eliminated by efficient combustion equipment, but rather may actually be increased.

• TODAY'S SMOKE LESSON, then, may be divided into several parts: First: "drives" and "education" are hollow mockery unless keyed to the actualities of human nature, business finance and available equipment.

• SECOND: IT IS HUMANLY IMPOSSIBLE at present to STOP smoke by legal force, although "black smoke" can be diminished.

• THIRD: IT IS NOT YET PRACTICABLE to compel the use of flue-gas cleaners on all installations because it is still impossible to buy and operate at low cost equipment that will remove all but a trace of dust and sulphur.

• FOURTH: A FIRST STEP is to require all new combustion installations to pass inspection and thereafter to penalize such stacks making dense smoke under normal conditions.

• FIFTH: USERS AND MANUFACTURERS alike should persist in research designed to perfect and cheapen devices for cleaning stack gas of dust, cinder, fly-ash and sulphur gases.

• THIS IS A LONG ROW TO HOE. The end will not be reached in our life-time. It is the engineer's job to lay the facts on the table.

YOU ARE INVITED

THIS YEAR *Power* rounds out its first half century of life. Commemorating this golden anniversary, but dedicated to the practical needs of present-day readers, will be a great June number—probably the greatest number in *Power's* history. More than ninety colorful pages will depict the past, present and future of power generation, transmission and application.

Among those "listening in" will be many long-time readers, men who have been with us as subscribers for twenty-five, thirty, forty and even fifty years. We are reserving space in July for these old-timers.

If you have been a constant reader of *Power* for twenty-five years or more, please tell us how long and send in your reminiscences of the good old days (or your slant on the present or future, if you prefer). Anecdotes and "arm chair conversation" will be in order. Write as much as you want, and the editors will select interesting paragraphs for publication.

FLOCK OF DIESELS

"THE TREND," says the sage, "is toward fewer and larger units, thus insuring lower first cost and higher efficiency." Sounds familiar and is getting to be the good old orthodox power doctrine applied indiscriminately to all types of prime movers.

This may be all right for steam prime movers, but has a tendency to go haywire on diesels. The small diesel is almost as efficient as the large. Installation of many small units requires less spare capacity. Small units can be more economically loaded. Quantity production promises much lower cost of small diesels (200 horse and less). It's getting harder to escape the logic of the flock-of-small-diesels power plant, now urged by several eminent authorities.

STEAM—RUBBER—ELECTRICITY

ABOUT EIGHT YEARS AGO, when engineering thought was turning to high steam pressures in industry, *Power* pointed editorially to *rubber*. The rubber industry, said *Power*, should be a particularly fertile field for steam pressures because of high power loads and high process pressures. For that reason it is a pleasure to describe on page 225 the 800-lb. Goodyear plant. Firestone meanwhile builds for 1,400 lb.

"LONG ON MEN"

N. T. PEF, on page 245, draws a nice distinction between two power-plant types: "chief engineer" and "efficiency man." The first, he suggests, is strong on handling men, very practical in matters of straight mechanics, maintenance and reliability, but is inclined to overlook chances to apply "book knowledge." At the other extreme, the efficiency man often prefers books to tools, and formulas and records to men.

Each type has its place in the production and delivery of dependable power services at minimum cost. Every well-operated power plant has a "chief" and an "efficiency man," whether they happen to be a single person or two that understand each other and know how to team up for results.

1934 MODEL

"I TRIED THAT ONCE, and it wasn't satisfactory." Occasionally you hear this remark applied to today's equipment or process by a man whose actual experience with something of this class or make ended ten or fifteen years ago. Imagine condemning a 1934 model automobile as slow or rough riding on the basis of a bumpy ride back in 1920. Yet one continually encounters engineers whose opinion on welding, stokers, pulverized coal, diesel engines or what-have-you has no better foundation. It's not safe to overlook the progress that is made year after year in every branch of engineering.

DEBUNKED EDUCATION

NO MAN SETS greater store by education than the man who lacks it. To such, America's invitation is "come and get it." In night schools, correspondence schools and books, he can find about all the education any man could find in a college.

Fine, but there's one fly in the ointment. Too frequently, the valuable elements of education are carefully compounded with time-consuming bunk, the window dressing of intellectual snobbery. It's a crime to pile such mental hazards in the path of the hard-working, ambitious man who wants the corned beef and cabbage of education without the frills.

POWER STANDS FOR

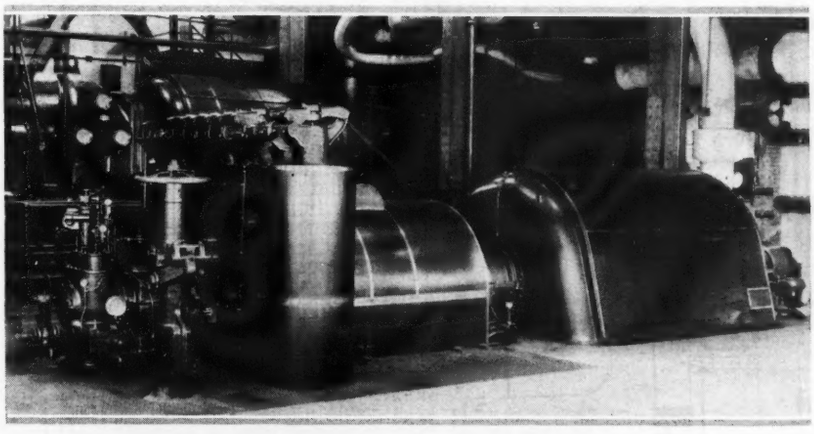
1. Making power when it should be made
2. Buying power when it should be bought
3. Cheaper power through modern equipment
4. Easier financing of equipment purchases
5. Better use of by-product heat and power
6. Operating methods that save money
7. Less waste in transmission and application
8. Prevention of smoke, within reason

By HARRY A. DAVIS
Manager, Steam Engineering Division
Goodyear Tire & Rubber Company

GOODYEAR INSTALLS 800-LB.

STEAM- AND POWER-GENERATING SYSTEM

Often modernization must be accomplished in limited space. Goodyear did it by installing a 300,000-lb. per hr. boiler operating at 745 deg. F., and a 7,500-kw. non-condensing, extraction type turbine-generator



New 7,500-kw. turbine-generator, with old units behind it

GOODYEAR TIRE & RUBBER CO., at Akron, Ohio, is one of the largest plants in the world devoted to the manufacture of high-grade rubber goods. Its steam and power requirements are proportionately great. In 1933 the management requested a power-plant study to determine what economies would result from installing a new high-pressure boiler and a turbine-driven alternator. Any changes in steam and power-generating equipment had to be limited to the site of the old plant.

In the old plant, steam at 200 lb. gage and 530 deg. F. total temperature was delivered from the boiler directly to a header. From this main, all generating equipment in the power house was supplied and 100-lb. process steam was delivered through a reducing valve to the factory. Analysis of the previous 5-yr. operating records showed that about 50 per cent of the steam went to process and 50 per cent was used for power generation, and that process-steam requirements ranged from about 150,000 to 285,000 lb.

A plan of modernization was worked out whereby several of the old boilers could remain available for standby service, while normal steam requirements were supplied by a new high-pressure boiler unit. The plan also included a new extraction-type turbine-generator taking its steam directly from the new boiler and exhausting at high back-pressure. This plan had the advantages of low initial investment, substantial increase in plant capacity, retention of the present low-pressure turbines in regular service or for operation when the high-pressure unit is down for inspection. The low-pressure turbines can also be operated from the old boilers in case of trouble with the high-pressure unit.

It was found that by removing four old boilers, raising the boiler-house roof and using the old coal- and ash-handling equipment, space could be made for the new boiler. There was space for the new turbine-generator in the turbine room.

Before the steam pressure for the new unit was selected, economic studies were made for pressures from 550 to 1,200 lb. From these it was decided that steam at 800 lb. gage and 750 deg. F. total temperature was best suited to the conditions.

When the steam-generating equipment was selected, the boiler, furnace, superheater, air preheater and pulverized-coal burners were considered as a unit, each part being proportioned to give a well-balanced efficient installation.

Cross-Drum Boiler

The boiler is a B. & W., horizontal, cross-drum, sectional type, designed for 800 lb. working pressure and 740 to 745 deg. F. total temperature at the superheater outlet. It has an effective heating surface of 20,131 sq.ft., with a capacity of 300,000 lb. of steam per hour. The interdeck superheater has a heating surface of 3,105 sq.ft., the tubular air heater an effective heating surface of 33,400 sq.ft. The air heater is so designed that in case of induced-fan failure the heater will be by-passed automatically and the boiler operated on natural draft at about 50 per cent of maximum rating.

Bailey stud construction is used on all four walls from about 1 ft. above the floor to approximately 13 ft. above, and smooth, bare, metal blocks on the floor and all four walls above the studded portions. Presenting a continuous heating surface to the fire, the total area

of water-cooled furnace and floor is 2,776 sq.ft., and at maximum load the heat liberation is 32,700 B.t.u. per hr. per cu.ft. of furnace volume.

Slag and ash resulting from combustion are kept molten in the furnace bottom and drawn off at suitable intervals in a specially designed sluice. In this sluice, water jets discharge in the molten slag and break it up so that it can be carried out for disposal into the present ash hopper.

The boiler is equipped with four pulverized-coal, cross-tube burners, two in front and two in back of the furnace. Each pair of burners is fed by one pulverizer with a capacity of 22,500 lb. per hr., with a guaranteed fineness of 80 per cent through 200-mesh screen. Burners are so arranged that balanced combustion conditions are obtained. Opposed firing, as used in this furnace, avoids direct flame impingement on the side walls. It also gives great furnace turbulence, improves combustion and reduces combustion time. This probably reduces carbon in the ash and slag accumulations on the boiler tubes.

Coal is dumped from hopper-bottom cars into a track hopper, fed through a crusher, then conveyed by an apron feeder into a pivoted bucket conveyor. This conveyor runs the entire length of the boiler-room bunker and is equipped with an automatic tripper for distributing raw coal to the bunkers. Ashes are removed by the same conveyor and are deposited into an ash bin directly over the railroad track for disposal in railroad cars. As now arranged, coal-handling equipment has a capacity of 100 tons per hour.

Forced- and Induced-Draft Fan Equipment

One induced-draft fan and two forced-draft fans are provided, designed to handle the air and gases when the boiler is operating at its maximum rating. The induced-draft fan is designed for maximum delivery of 180,000 c.f.m. of gas per hour at 467 deg. F. against a negative static pressure of 10.24 in. of water. The forced-draft fans are designed for maximum delivery of 78,000 c.f.m. of air per hour at 80 deg. F. against a static pressure of 7.51 in. of water. All three fans are driven by 50 per cent speed-control, slip-ring, splash-proof motors with enclosed collector rings.

Feed-water System

A hot-process water-softening system using the Hall system of phosphate feeding is installed, complete with deaerating heater. The system for heating feed water gives fairly high efficiency without introducing undue complications. At present, approximately 50 to 60 per cent of the makeup water is condensate returns from the factory and is slightly contaminated. This is collected in a large surge tank and pumped directly to the water softener. Condensate from the old turbines is piped directly to the deaerating heater, and the balance of makeup is taken from the city water main. Steam for heating feed water is taken from the exhaust system, which collects flash steam from the continuous blow-down system and exhaust from all steam-driven auxiliaries.

The deaerating heater has a storage capacity of 7,500 gal. to which the boiler-feed pump suctions connect.

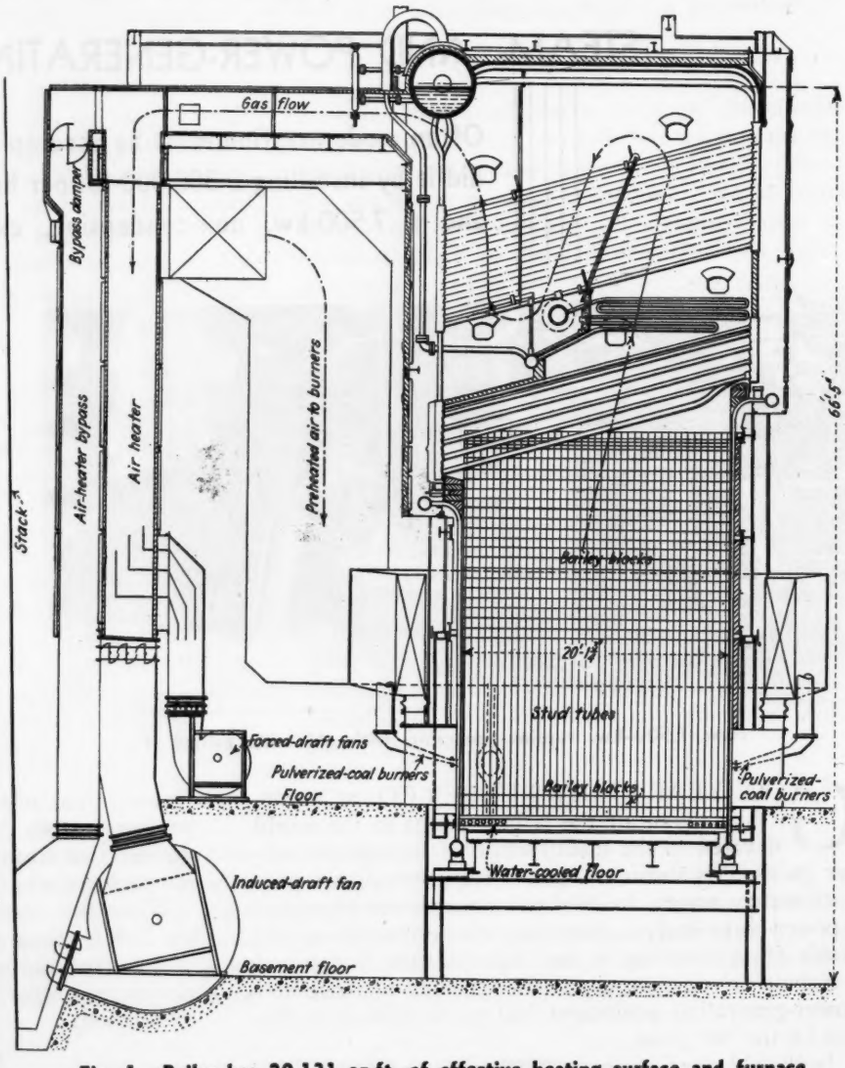


Fig. 1—Boiler has 20,131 sq.ft. of effective heating surface and furnace water walls and floor 2,776 sq.ft.

There is one turbine-driven and one motor-driven boiler-feed pump. Each pump has more than sufficient capacity to supply the new boiler. Both operate at 3,550 r.p.m., which reduces their size and cost and makes them well adapted to direct drive by either motor or turbine. Ordinarily, the squirrel-cage, motor-driven pump is used and the turbine-driven pump is held in reserve. Control of the motor-driven pump is so arranged that in case of an electrical disturbance, the steam-driven unit will automatically pick up the load. Boiler-feed piping presents no features, other than to allow the boiler to be fed at either end of the drum. At one end of the drum, feed is through an automatic regulator preceded by a differential pressure valve to

regulate pressure across the regulator. At the other end the feed is through an independent line controlled by a manually operated valve.

Piping System

All high-pressure steam piping and feed-water lines are of seamless drawn-steel tubing. High-pressure steam joints 6-in. in diameter and above are Sargol type, except those connecting immediately to the boiler, superheater and turbine. These joints, as well as all steam joints on 1½-in. to 6-in. piping are large male-and-female. Only lap flanges are used, all tongue-and-groove or male-and-female facings being made in the lap of the pipe. Joints in the boiler-feed lines are small tongue-and-groove. Copper gaskets are used in the tongue-and-groove and male-and-female connections.

All studs for the high-pressure, high-temperature, flanged joints are chrome-molybdenum steel threaded the full length. Flange joints were first made up with temporary studs and all Sargol joints welded while the studs were under tension, not more than three studs being removed at a time to do the welding. After a section of the line had been made up with temporary studs, permanent studs were installed one at a time, replacing the temporary ones. Nuts are hot forged and cold pressed to U. S. Government Standard.

All high-pressure gate valves are furnished with Exelloy seats Nitralloy disks, and all gate valves in the steam header and turbine leads are motor-operated.

Operation of Boiler Control

In an automatic combustion-control system there is a master sender, small enough to be mounted on the rear of the boiler instrument panel. The master is connected to the steam header and will build up a varying air pressure of from 10 to 50 lb., depending on steam pressure. This variable air pressure is the master impulse which controls fuel and air supply and furnace draft.

The control system responds to variations in steam demand by first adjusting induced-draft-fan speed and outlet-damper position. This is done by impulses from the master to a load-control relay at the instrument panel. This relay generates a second impulse, which under normal conditions can be increased or decreased by manual adjustment of the relay. The impulse from this relay loads the uptake draft controller to maintain correct draft at the boiler outlet. Indicators mounted on the panel show the value of the master impulse and of the loading impulse which controls draft.

Each change in uptake draft produced by a change in load tends to alter the combustion-chamber draft. In response to such changes a combustion controller, acting as a furnace-draft regulator, controls forced-draft fan speed and the position of the dampers between fan and burners.

A standard receiving regulator controls the speed of the pulverized-coal feeders by adjusting the rheostat position to control the speed of these motors. The impulse for control of fuel supply comes from a ratio relay that receives its impulse from the load-control relay and transmits a second impulse to the fuel-feed regulator. An indicator at the panel shows the rate of fuel supply, also the direction and extent of any manual adjustment that may be made.

It is frequently assumed that the draft loss across a boiler varies as the square of the weight of gases being handled. There are many variables, however, such as changing direction of gas flow and temperature and possible accumulations of soot or slag, that cause

Fig 2—Four pulverized-coal burners are provided, arranged in pairs on opposite sides of the furnace

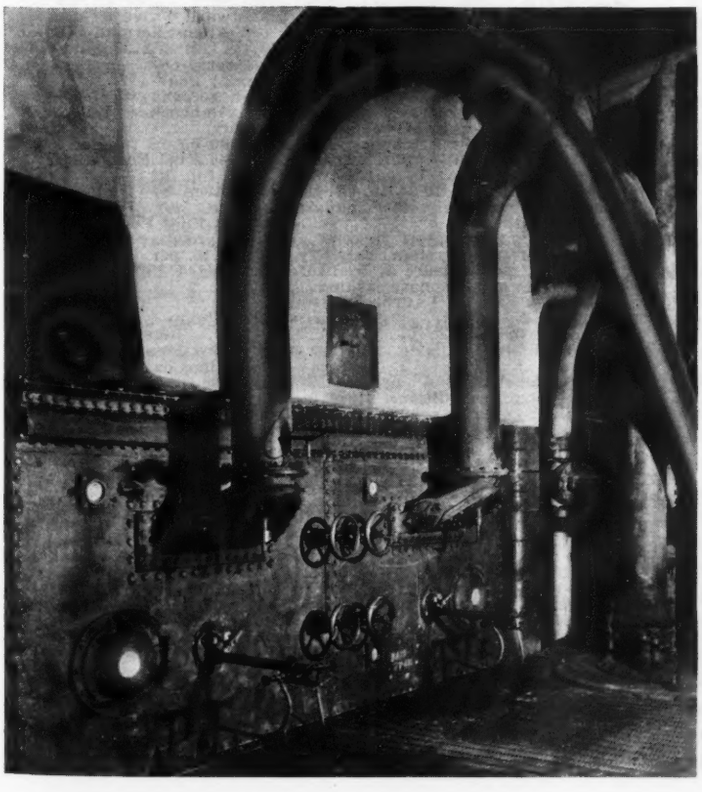
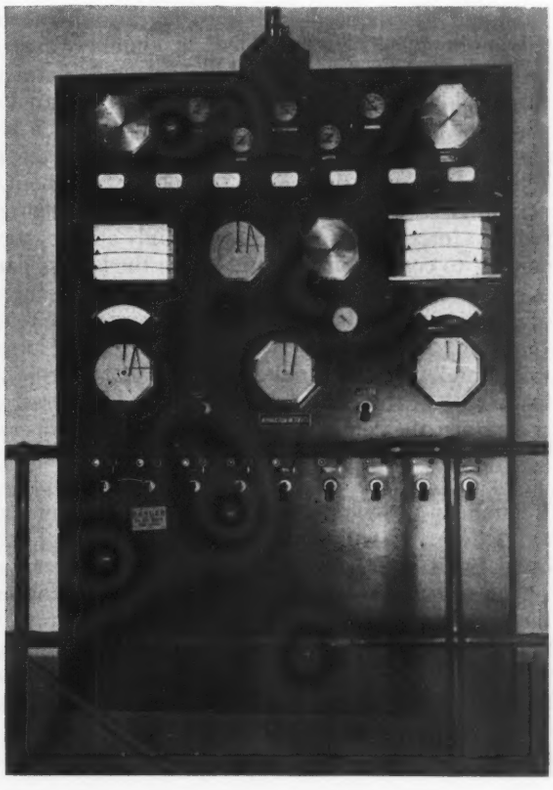


Fig. 3—Control and meters for the entire boiler equipment are on this panel



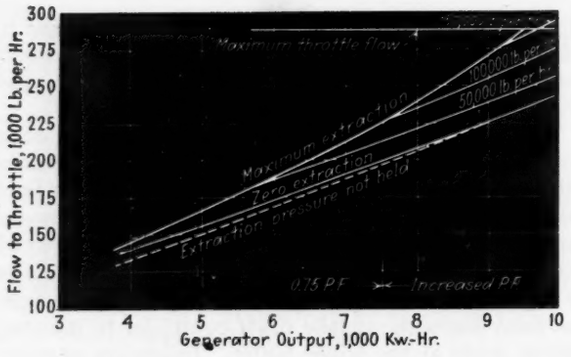


Fig. 4—Curves of turbine performance when different quantities of steam are being extracted; exhaust pressure 100 lb. and 200-lb. extraction

this relation to be undependable. Further, it is often assumed that coal supplied by a feeder is directly proportional to its speed. In general, this is correct, but not always so.

In order to proportion fuel and air properly with the combustion-control system, tests on the boiler were made to determine the proper adjustment. For each boiler load the master will generate a definite loading impulse which is balanced by the boiler-outlet draft. For each value of outlet draft, tests were made to determine the feeder speed required to give the desired fuel-air ratio.

The ratio relay permits manual adjustment of fuel supply with respect to uptake draft, regardless of whether the boiler is on manual or automatic control. Provision is not made, however, for manual control of fuel and automatic control of air supply. It is undesirable to provide means by which the operator might set the fuel at a given rate and then permit load variations to alter the uptake draft and rate of air supply.

Bypass Damper Control

Should the induced-draft-fan motor fail, the boiler will automatically be operated on chimney draft. A receiving regulator actuated by a solenoid-operated air valve holds the bypass damper closed on the air heater when the induced-draft-fan motor is running. If this motor stops, the bypass damper is immediately opened. This will permit the boiler to operate at about half maximum capacity. The furnace-draft regulator will reduce forced-draft fan speed and adjust the air damper to correct air supply. When the bypass damper is opened, a control impulse is sent to the fuel-feed regulator to set the feed-motor rheostats to readjust fuel feed. All these operations are performed automatically, and when the induced-draft-fan motor is again in operation, the control will close the bypass damper and return the combustion system to normal operation.

Power-Generating Unit

The new turbine-generator is a G.E. non-condensing extraction-type with direct-connected exciter. It has a capacity of 7,500 kw. at 0.75 per cent power factor, runs 3,600 r.p.m. and is rated with steam conditions at the throttle of 725 lb. gage and 725 deg. F. total temperature. The turbine is arranged for extraction of 150,000 lb. of steam per hour at 200 lb. gage to operate the old turbine-generators at full load when necessary. When no steam is being extracted from the new unit, all steam passes to exhaust at 100 lb. for process use, and the turbine operates as a straight non-condensing machine. The curves of Fig. 4 show turbine operation with steam at various conditions and the quantities of steam that may be extracted.

Both the back-pressure and extraction lines are protected by relief valves, also a thermostatically controlled desuperheater is installed in the low-pressure steam line and adjusted to supply steam at 100 lb. gage for process from the high-pressure, high-temperature line. Normally the desuperheater functions only in case of high-pressure turbine-generator trouble.

The general design of the new boiler and power-generating unit is a great improvement over the old installation. The wall between boiler and turbine rooms has been removed, giving the operator a clear view of all equipment under his charge. Under normal conditions the unit will operate under full-automatic control. Control of the entire unit is centralized on a panel where the operator can see both turbine and boiler. This makes it possible to maintain close supervision over the entire plant's performance.

No elaborate changes were necessary in the old electrical distribution system. Available space on the switchboard was utilized and one 3,000-amp. oil circuit breaker added, permitting connection to be made directly into the existing bus system.

PRINCIPAL EQUIPMENT IN POWER PLANT

EXTENSION OF GOODYEAR TIRE & RUBBER CO.

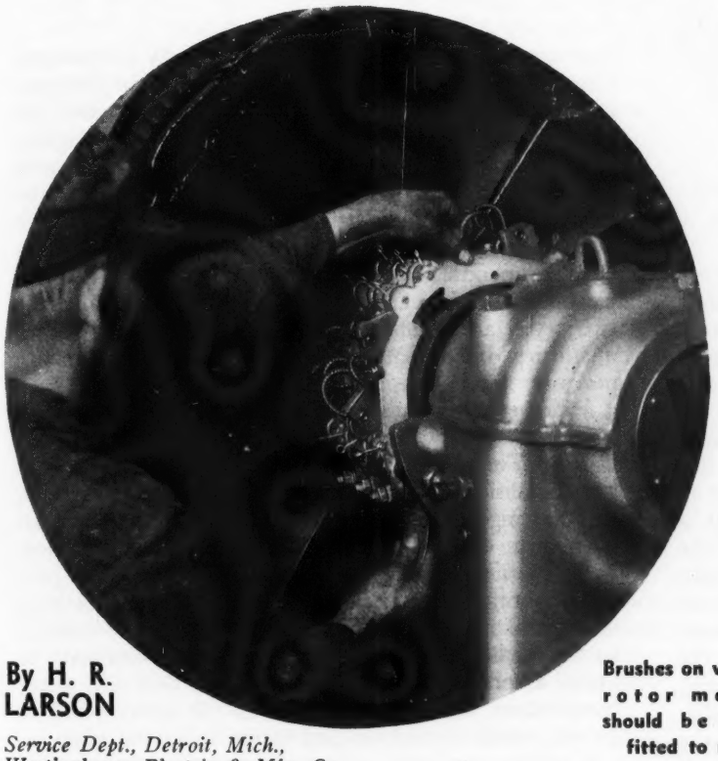
Boiler superheater and air preheater and water walls: boiler heating surface, 20,131 sq.ft.; pressure, 800 lb.; total steam temperature, 745 deg. F.; max. steaming rate, 300,000 lb. per hr.; superheater heating surface, 3,105 sq.ft.; air-preheater heating surface, 33,400 sq.ft.; furnace water walls, Bailey type; area including furnace floor, 2,776 sq.ft.; maximum heat liberation, 32,700 B.t.u. per hr. per cu.ft. furnace vol.	Babcock & Wilcox Co.
Breechings	Babcock & Wilcox Co.
Water columns	Diamond Power Specialty Corp.
Feedwater regulator, Copes	Northern Equipment Co.
Soot blowers	Diamond Power Specialty Corp.
Non-return valves	Edward Valve & Mfg. Co.
Blowoff valves	Edward Valve & Mfg. Co.
Ash sluicing system	Allen-Sherman-Hoff Co.
Automatic combustion control	Hagan Corp.
Coal pulverizers and burners: 4 pulverizers, capacity, each, 22,500 lb. of coal per hour; guaranteed fineness 80% through 200-mesh screen; 4 cross-tube burners	Babcock & Wilcox Co.
Pulverizers driven by Allis-Chalmers motors.	
Forced-draft fans: 2; capacity, each, 78,000 c.f.m. at 80 deg. F. and 7.51 in. of water	Green Fuel Economizer Co.
Induced-draft fans: 1; capacity 180,000 c.f.m. at 467 deg. F. and 10.24 in. of water. Driven by Allis-Chalmers slip-ring motors to give 50% speed control	Green Fuel Economizer Co.
Deaerating feed-water heater and hot-process water-softening system: capacity, 700,000 lb. per hr.; final temperature of feedwater, 216 deg. F.	Cochrane Corp.
Hall system of phosphate feeding	Buromin Co.
Boiler-feed pumps: 1 turbine-driven.	Worthington Pump & Machry. Corp.
1 motor-driven	Ingersoll-Rand Co.
Turbine	Moore Steam Turbine Co.
Motor	Allis-Chalmers Mfg. Co.
Turbine-generator: 1 non-condensing extraction type; steam conditions, throttle, 725 lb. g., 725 deg. F.; capacity 7,500 kw. at 0.75 p.f.; extraction pressure, 200 lb.; exhaust pressure, 100 lb.	General Electric Co.
Reducing valves	Schutte-Koerting Co.
Desuperheater	Schutte-Koerting Co.
Atmosphere relief valves	Atwood-Morrell
High-pressure valves	Crane Co.
Low-pressure valves	Crane Co.
Traps	Strong, Carlisle & Hammond Co.
Piping	Grinnell Co.
Pipe covering	Gustin-Bacon Mfg. Co.
Boiler-meter board	Republic Flow Meters Co.
Feedwater meter	Republic Flow Meters Co.
Steam flow meters	Republic Flow Meters Co.
Draft gages	Republic Flow Meters Co.
Flue-gas analyzer	Republic Flow Meters Co.
Pressure gages, indicating	Consolidated Ashcroft Hancock Co.
Pressure gages, recording	Bristol Co.
Indicating thermometers	Bristol Co.
Recording thermometers	Bristol Co.
Temperature and pressure recorders	Bristol Co.
Indicating pyrometers	Brown Instrument Co.
Smoke indicator	Westinghouse Elec. & Mfg. Co.

COMPETENT MOTOR MAINTENANCE

PAYS DIVIDENDS

By H. R. LARSON

Service Dept., Detroit, Mich., Westinghouse Electric & Mfg. Co.



Brushes on wound-rotor motors should be well fitted to rings

WHEN you install an electric motor drive, be reasonably sure that the application is correct, If the load duty of the machine being equipped is not known, by all means find it out. Alternating-current motors with characteristics suitable for most applications can be obtained, but that does not mean that a general-purpose motor picked without regard to starting characteristics, torque and other features will give 100 per cent satisfaction. It costs nothing to use the motor manufacturer's experience when making applications; you'll find him just as interested in having the job right as you are.

No motor should be operated continuously overloaded. If you doubt whether a motor has sufficient capacity, it is relatively simple to determine the power required by instruments. Any well-designed motor will stand temporary overloads, but they should not be continued until the motor burns out.

Several months ago I visited a plant where it was difficult to keep electrical equipment in operation. In this plant output had increased month by month without corresponding increases in power facilities. As a result practically all equipment was loaded to more than twice that originally intended. Behind one of the distribution switchboards a long row of fuse clips was found filled with ordinary flat files discarded from the machine shop. Currents required by the overloaded motors were too high for the largest fuses that could be installed in the clips, so files had been resorted to.

Modern controllers with inverse-time-limit overload protection are reliable and inexpensive. A motor is worthy of this protection. Motors are now available with built-in protection in the form of a thermostat on or adjacent to the windings. This thermostat is connected to either trip the motor off the line, or ring an alarm if the temperature of the windings becomes excessive.

A good alternating-current motor operating within its rating and kept clean and dry may run indefinitely. This presupposes periodic inspection and oiling of bearings. There is no substitute for cleanliness. While blowing dirt and dust out of windings periodically with compressed air is desirable, the most satisfactory way to clean a motor is to dismantle it in a shop. If every motor could be thoroughly cleaned periodically, then be given a varnish treatment and baked, it would add immeasurably to winding life.

Because an electric motor operates under severe conditions of dirt and moisture, don't expect it to do so indefinitely. Dirt is the great enemy of electrical equipment. Any kind of dust will clog ventilating ducts and cause increased winding temperatures. If the dust or dirt is more or less an electrical conductor, it will gradually permeate the insulation and form low-resistance paths, eventually contributing to a breakdown. The man who first said "Cleanliness is next to Godliness' may never have seen an electric motor, but this old adage certainly applies to electrical equipment.

Make periodic inspections. It is impossible to lay down specific rules that will apply to all plants, because conditions vary. Motor manufacturers' service engineers will gladly give specific advice. Plants in which thorough inspections are made at frequent intervals have the least trouble. Old-type sleeve bearing motors should be looked at at least once a week, the proper bearing oil level maintained and the bearings checked for play. On motors, particularly of large size, the air gap should be checked with feeler gages once a month.

When it becomes necessary to repair a motor, the same discrimination should be used as in its purchase. Too often, in the rush to get equipment back in operation, this is not done and further breakdowns occur shortly. In some plants all that is left of the original motor equipment is the frame, the nameplate and a feeling that the manufacturer is still responsible for continued satisfactory operation.

INCREASE REFRIGERATION CAPACITY
DECREASE POWER PER TON
BY EFFECTIVE USE OF CONDENSING WATER

By LEON BUEHLER, JR.
Waynesboro, Pa.

When to use atmospheric cooling of condensing water—Where to introduce makeup water—What can be gained by cooling liquid refrigerant

EFFICIENCY in a refrigerating plant is highest when head pressure is lowest. An exception occurs when operating above or near the critical point, as with carbon dioxide, where supercharging gives improved results. In any case, low condensing temperature is essential.

Operating economy is also affected by the temperature of the liquid at the expansion valve. Usually this liquid is at its boiling point and must first be cooled to the evaporating temperature in the cooler before it is useful in providing cooling effect. The portion of the liquid evaporated in cooling itself is no longer available for useful refrigeration. The higher the temperature of the liquid fed to the expansion valve, the greater will be this wasted portion, and the less will be the refrigeration supplied by a given quantity of refrigerant. Power required by a compressor of given displacement is not affected by the temperature of the liquid, but with cold liquid the same displacement will give more useful refrigeration for the same power. Thus the horsepower per ton of refrigeration is reduced with cold liquid, and capacity of the plant is correspondingly increased.

Usually the liquid will be somewhat colder than the temperature corresponding to head pressure. This may be mistaken for subcooling, but it is due to the presence of non-condensable gas. Liquid temperature will actually correspond closely to the partial pressure of the ammonia. Engineers at times mistakenly look upon this apparent subcooling as efficient condenser operation. If they will purge, however, head pressure will drop without affecting the temperature of the liquid, showing that operation was actually inefficient. Subcooling of liquid is best accomplished between the receiver and the expansion valve, as in Fig. 1.

To satisfy the condition of lowest head pressure, large quantities of condensing water and a large condenser are required. These remarks refer only to the efficiency of the compressor and do not take into consideration auxiliary power nor investment for equipment. Cost puts a limit upon condenser size beyond which head pressure is no longer reduced sufficiently to justify the investment. Cost of condensing water or cost of pumping (where the water itself is free) limits the quantity that can be economically circulated. Usually with cooling tower or spray-pond, the economical balance occurs between 4 and 6 gal. of water per min. per ton of refrigeration. I favor the higher figure.

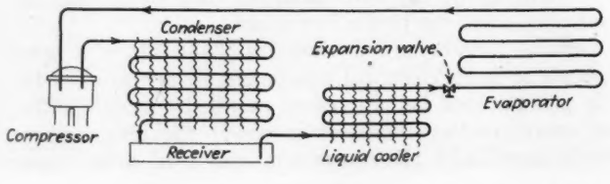
There are two general types of condensing-water systems. In the first, water is passed through the condenser just once, then discarded; in the other it is used over and over again, being cooled in a tower or spray pond with just enough make-up water to replace evaporation and drift losses. Occasionally the two types are combined in a system in which larger quantities of cold make-up water are added than are necessary, and there is a certain overflow.

Whether to use a spray pond or cooling tower as against wasting water usually depends upon the cost of water. The deciding factor, however, may be other local conditions, such, for example, as occurred during the starting up of a new ice plant. Apparently an abundance of cold water was available from shallow wells so that pumping cost was low. Adequate provision for getting rid of the used water had not been made, and it developed that this could only be done at an impossibly high cost. It was therefore necessary to install a spray pond in spite of the fact that well-water temperature would be much lower. A spray pond or cooling tower should be used in the following cases:

1. When available water is warmer than sprayed water.
2. When water is scarce.
3. When purchased water is more expensive than the cost of makeup water plus pumping costs and fixed charges on the tower or pond.
4. When the cost of pumping from deep wells, etc., is greater than the total cost of operating a tower or pond.
5. When available water is so highly scale-forming or corrosive that cleaning and replacement costs of condensing equipment outweigh the operating costs of the tower or pond.
6. When waste water cannot be disposed of.

The nuisance factor in a tower or spray pond installation should not be overlooked. One of the most frequent causes of contention with neighbors comes from water carried to adjoining property by winds.

Fig. 1—Piping plan showing location of liquid cooler



When an abundance of cold water is used, it should all be put through the condenser. With a small amount of available condensing water, efficiency can be improved and plant capacity increased by first using water to subcool the liquid before passing to the condenser. For instance, when using only 1 g.p.m. per ton of refrigeration, this procedure will result in about a 7½ per cent increase in capacity with an expenditure of only about 3 per cent additional power for the compressor.

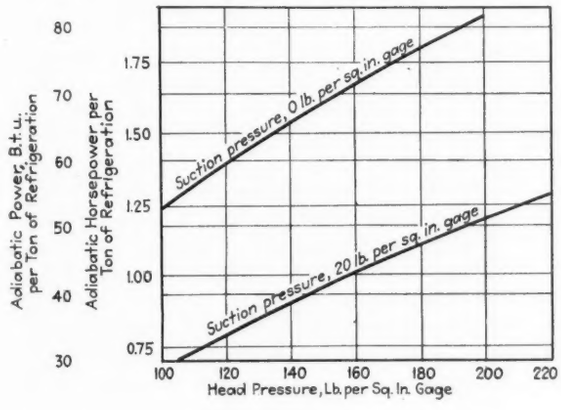
When the makeup water to a cooling tower or spray pond is warmer than the pond water, it is best to pass the makeup over the tower or through the sprays before it reaches the condenser. Makeup usually is only 1½ to 2 per cent of the water circulated, so it makes little difference where it is added, unless it is very much warmer than pond water. Usually the governing factor is one of convenience and elimination of extra pumping power.

If makeup water is considerably colder than the pond water, it may be used to precool the liquid before being added to the pond water. With makeup water 30 deg. colder than the pond, an increase in capacity of 5.7 per cent with a saving of about 5 per cent in horsepower per ton may be obtained.

Thermodynamically, a saving can be shown in every case by first using water for liquid cooling before passing it over the condenser, even though the result is always an increased head pressure—negligibly small in many cases. The added cost of providing a liquid cooler with the attendant plant complication, plus in some cases additional pumping expense, outweighs the benefits excepting where computed savings are quite large. It is well to remember that it is of no benefit to cool the liquid, then allow it to warm up again before it reaches the expansion valve. Wherever the liquid is cooled below the atmospheric temperature, it is necessary to insulate the liquid lines to retain the full benefit of the cooling.

A case in which results were quite spectacular comes to mind. I made a survey of the plant of the Mutual Ice Co., Alexandria, Va., for the purpose of planning a complete modernization to be accomplished in three or four years. This plant had started modestly and through the years had grown to a capacity of between 400 and 500 tons of ice per day. It used a spray pond and a battery of vertical shell-and-tube condensers. Makeup water at 50 to 55 deg. from a deep well was

Fig. 2—Adiabatic power per ton of refrigeration with ammonia



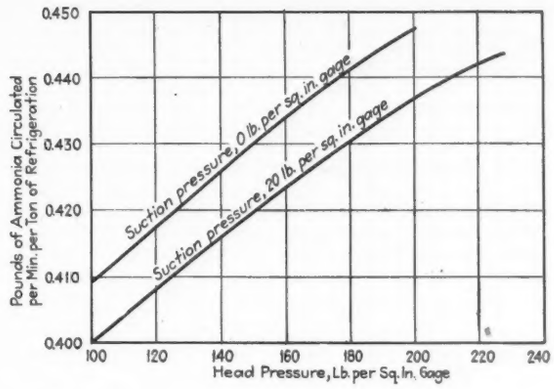


Fig. 3—Ammonia circulated per ton of refrigeration

pumped over one condenser. It was decided to convert this one condenser into a liquid cooler. This liquid was to be further cooled at high suction pressure by a separate ammonia compressor. Conversion of the condenser only required reconnecting some of the ammonia lines at a negligible cost. The plant was electrified at the same time, so that an exact comparison with former operating conditions was not possible. However, the changes did give the desired increase in capacity, and the reduction in temperature of the liquid at no increase in pumping power is convincing evidence of increased economy which returned the initial investment in a few months. The theoretical figures show a return of over 200 per cent annually on the cost of the change to the lines.

The following numerical example illustrates the method of analyzing this problem. The curves of compressor power, Fig. 2, are theoretical value based on the ammonia tables and adiabatic compression. Actual power requirements are naturally greater. It is felt, however, that the economies expressed in percentages are nearly correct for actual operating conditions. The values for increase in capacity should also hold good in practice. In solving the problem, 180 lb. head pressure was assumed in order to compute the temperature rise of the water. This value did not exactly check that computed later. The figure for 180 lb. was, however, retained, as correcting for the discrepancy would not measurably affect the final result.

Assume 6 g.p.m. of 85-deg. spray-pond water per ton of refrigeration, 2 per cent makeup, or 0.12 g.p.m. per ton refrigeration at 55 deg., 20-lb. gage suction pressure.

Try 180 lb. head pressure
Heat after compression 723 B.t.u. per lb. of ammonia
Heat of liquid at 180 lb. 149 " " " " "
Heat removed in condenser 574 " " " " "
Pounds ammonia circulated per minute from curve 0.43 (Fig. 3)
Heat removed in condenser per min. per ton refrig.

$$574 \times 0.43 = 247$$

$$\text{Final temperature condenser water} \frac{247}{8\frac{1}{3} \times 6} + 85 - 89.94 \text{ deg.}$$

Expect head pressure 5 deg. above outlet water or at

$$94.94 = 180.9 \text{ lb. per sq.in.}$$

Final temperature of mixing spray and makeup water

$$\text{mixture} \frac{6 \times 85 + 0.12 \times 55}{6 + 0.12} = 84.4 \text{ deg.}$$

$$\text{Temperature off condenser} \frac{247}{8\frac{1}{3} \times 6.12} + 84.4 = 89.25 \text{ deg.}$$

Expected head pressure 5 deg. above outlet water or at
$94.25 = 178.8$ lb.
Say cool liquid to 72 deg.
Heat of liquid at 95 deg. 149.4 B.t.u. per lb.
" " " " 72 deg. 122.8 " " "
Heat removed 26.6 " " "
Heat removed per ton refrigeration $26.6 \times 0.43 = 11.4$ B.t.u.

$$\text{Final water temperature} \frac{11.4}{0.12 \times 8\frac{1}{3}} + 55 = 66.4 \text{ deg.}$$

The assumption of cooling liquid to 72 deg. can be attained
Mixing makeup water from liquid cooler than spray water
Final temperature of mixture

$$\frac{0.12 \times 66.4 + 6 \times 85}{6.12} = 84.6 \text{ deg.}$$

$$\text{Temperature of condenser} \frac{247}{8\frac{1}{3} \times 6.12} + 84.6 = 89.45 \text{ deg.}$$

Expected head pressure at 5 deg. above outlet water or at
94.49 deg. 179.4 lb.
Adiabatic power at 180.9 lb. 47.5 B.t.u.
" " " 178.8 lb. 47 15 B.t.u.
" " " 179.4 lb. 47.3 B.t.u.
Heat removed from liquid 11.4 B.t.u.
Refrigerating effect of same amount of precooled liquid as would be circulated per ton refrigeration unprecooled
$200 + 11.4 = 211.4$ B.t.u.
Per cent increased capacity for same displacement by

$$\text{precooling} \frac{211.4}{200} - 1 = 5.7 \text{ per cent}$$

$$\text{Adiabatic power per actual ton refrig.} \frac{47.3}{105.7} = 44.8 \text{ B.t.u.}$$

Saving in power by liquid cooling $47.15 - 44.8 = 2.35$ B.t.u.

$$\text{Per cent saving in power by liquid cooling} \frac{2.35}{47.15} = 5 \text{ per cent.}$$

64 DIESELS IN ONE PLANT ARE PRACTICAL

Says R. M. SCHAEFER
Engrg. Dept., Waukesha Motor Co.

This radical suggestion offers possibilities for low cost diesels and highly flexible stations. But what of electrical difficulties, for example? Comment if you agree or if you don't; other readers will be interested

THE use of batteries of light multiple-cylinder engines for the generation of power demands ordinarily supplied by extremely large slow-speed engines, may at first appear to diverge from tradition. However, the method has been frequently followed in gas-engine applications. One of the oldest installations in this country is that of Diamond Light & Power Co., Pittsburgh, Pa., constructed in 1898. In this plant, nine 85-hp. gas engine-generator sets were installed and additional units were added later.

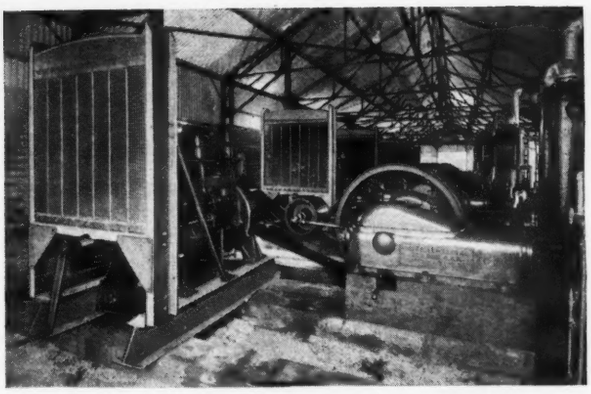
In the oil fields it has been the practice to use a number of multi-cylinder gas engines driving compressors for air-lifts and pumps for flooding and pumping. Continental rail-car designers have realized the advantages of such installations and are now testing rail cars driven by ten or even more engines.

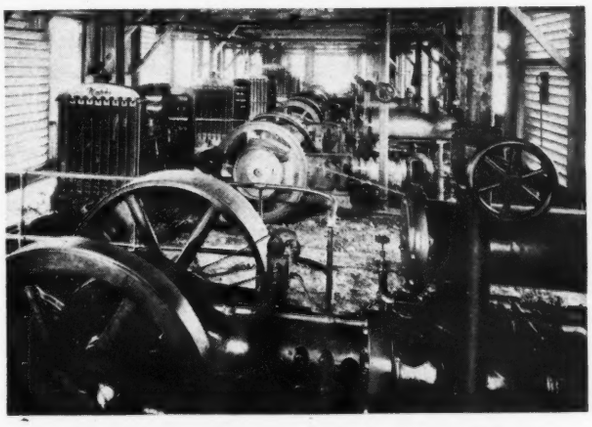
Multiple-engine installations, however, have not really been of acute interest until the recent development of the high-speed heavy-duty diesel for trucks, tractors, etc. A typical one has 6 cyls. of about 5-in. bore and 5½-in. stroke, and can comfortably deliver 100 hp. at 1,500-1,800 r.p.m. Such an engine, weighing 1,800 lb., would develop a maximum of 170 hp. at 2,400 r.p.m. and 120 hp. at 1,600 r.p.m., which would permit it to be rated very economically at 100 hp. This type has attained a high degree of mechanical perfection and has become so widely standardized that replacements are inexpensive. Further development and greater use will inevitably result in manufacture on a production basis, with attendant low unit costs.

Let us consider a typical diesel plant with a maximum power demand of 5,000 hp. Engineers will undoubtedly point out that light, high-speed units could not possibly equal the performance standards necessary for constant-duty service. Yet the average motorbus or truck operates approximately 5,000 hr. per year under varying atmospheric conditions and over its entire speed and load range, a most gruelling test for any engine. The so-called full-load rating at which large diesel engine tests are run generally corresponds to only about 75 lb. b.m.e.p., whereas any high-speed engine can quite easily develop 90 lb. b.m.e.p. with good economy. Rated full power would be about 80 per cent of what the engine is capable of developing. If actual power requirements of such installations are checked, it will generally be found that duirng the average day's run they will not exceed 80 to 90 per cent of rated output. Compared, therefore, with the many services in which light high-speed diesels have already proven satisfactory, the applications outlined above are relatively easy, especially since speed will be constant and overloading non-existent.

Reliability is the first essential. No prime mover can ever be 100 per cent reliable, and security can only be found in numbers. With two or three engines security is increased considerably, but with a large number of individual units security becomes virtually infinite, however frail the individual unit may be.

In a power plant requiring 5,000 actual horsepower, I suggest the installation of 64 diesel-electric generating





Two present-day multiple-unit plants, both oil-field stations

sets of 100 hp. capacity each when operating at 1,600 r.p.m. Allowing for a 14 per cent loss in electric transmission, 58 generating sets would be required for the maximum power demand, the remaining six sets being available for emergency or exchange for overhaul. As each set consists of a 6-cyl. engine and generator with light moving parts, fully balanced, no special foundation will be necessary and the units can be placed in rows, or even tiers. Relative position is immaterial, but for convenience of wiring and piping it would be advisable to place them close together. Cooling water, lubricating oil and fuel oil will be delivered from a central distributing system with all pumps in duplicate to insure reliability. Each set should have its own starter operated from a central control point. When once up to speed, it will cut in automatically and thereafter operate at constant speed and constant load.

The first criticism of such a scheme will be the cost of maintenance. A good deal of experience with small high-speed diesel engines in road service shows these engines are required to operate at considerably higher speeds than 1,600 r.p.m. They are frequently overloaded, constantly started and stopped, and are often left for long periods running idle. In such engines the principle wearing parts are the cylinder liners, piston rings, and connecting-rod bearings. The actual rate of wear in such small engines is no more than in large ones, but due to the smaller dimensions of the parts, less wear can be tolerated before renewals become necessary. Such renewals are, however, considerably less expensive and the total cost would be far less, especially since the plant would never have to be put out of operation for overhaul. Furthermore, it has been proven that the best remedy to reduce cylinder wear is to keep the cylinder walls well above the temperature that will permit condensation and thereby avoid corrosion. In such an installation, therefore, the cylinders would be cooled by means of hot water kept in circulation whether the engines were running or not. This water will be passed through a thermostatically controlled heat exchanger, maintaining constant water temperature of 170-190 deg.

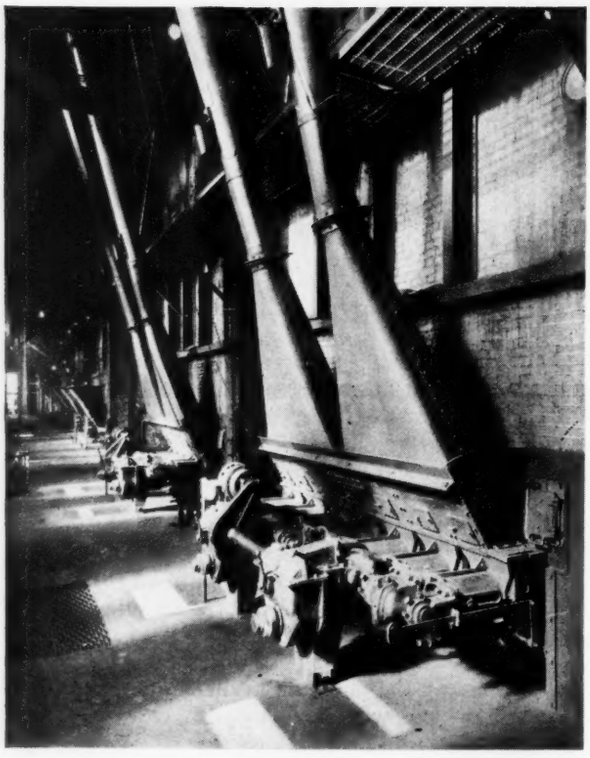
In this way, engines would be kept warm, and this would facilitate starting and reduce cylinder wear greatly. Under such operating conditions the rate of cylinder wear would be reduced to 0.002 for a 5-in. bore per 1,000 hours of operation, and the piston rings should be good for at least 4,000 hr. Lubricating oil will drain from the sumps of all engines into a reservoir. From this tank the oil will pass through a centrifugal cleaner, then an oil cooler to reduce temperature. From here it will be pumped into a tank of sufficient height to maintain a head equal to the pressure of approximately 15 lb. per sq.in. required to force the oil to all engine bearings. In this way clean cool oil will be supplied to all points requiring lubrication and the circulation should take place whether the engines are running or not. This will assure the oil being available when an engine is started up and will avoid the danger of an engine getting up to full load before the oil is sufficiently warmed up to circulate freely. The fuel system will be similar to the oiling system, with a continuous flow through the fuel pumps in order to avoid air bubbles forming vapor-locks in supply lines. The total amount of power required to drive the auxiliaries should not exceed 50 hp., or 1 per cent of total output, which is a very low percentage of power for this purpose.

Under such operating conditions a maintenance schedule would suffice whereby after each 2,000 hr. of operation an engine would be subjected to a top overhaul, which would include decarbonizing, valve grinding and adjustment of valve tappets, fuel injectors and fuel-injection pumps. After the next 2,000 hr. piston rings and valve springs should be renewed. After a total of 8,000 hr. an extensive overhaul should be scheduled whereby the main bearings would be tightened, cylinders reground if necessary, and new pistons, valves, etc., fitted. Such renewals would, at the utmost, amount to 10 per cent of the entire cost of the engine. Cost figures derived with such a maintenance schedule are very reasonable compared with expenditures for maintaining some slow-speed engines, especially as the plant is never out of operation for repairs, and such routine overhauls will maintain all engines in new condition and at maximum efficiency.

In order to eliminate noise, each engine should be set in a sound-proof box, well ventilated by means of a common ventilating system. Foundation problems which prevail with large engines can be entirely forgotten. Due to the high speed and lightness of moving parts, the specific fuel consumption of small engines is at least as good, and usually even better than that of slow-speed engines. Taking the efficiency of the electric transmission into consideration, a fuel consumption of 0.45 lb. per b.hp.-hr. can be readily obtained, only slightly more than that of a slow-speed engine. Although the lowest consumption of a multiple-engine plant may not be as low as that of a single large engine, over the entire load range it will show up favorably.

PUT ENGINEER IN CHARGE OF

He found and stopped many small wastes, thus brought about a continuous decrease in steam cost over a seven-year period



The Firing Aisle

Two 6,000-sq.ft. boilers in the foreground, and then in order, two 4,100-sq.ft. boilers, two 2,500-sq.ft. boilers, the boiler feed pumps, and four 2,860-sq.ft. boilers. A head fireman and three men comprise the firing crew.

MANY wasteful steam plants, regardless of the age of their equipment, can improve economy greatly if a capable supervisor will search for possibilities and follow them up with diligence. The plant with which I have been in close contact for the past seven years is a good example. Built and equipped during the years 1915 to 1918, with second-hand boilers of small individual capacity, it was far from modern, either as to equipment or arrangement, up to the early months of 1926. It had been carried along under supervision of production superintendents, who, naturally, had treated steam plant operation as a side issue of minor importance, as long as steam flowed to the mill in sufficient quantities to maintain production.

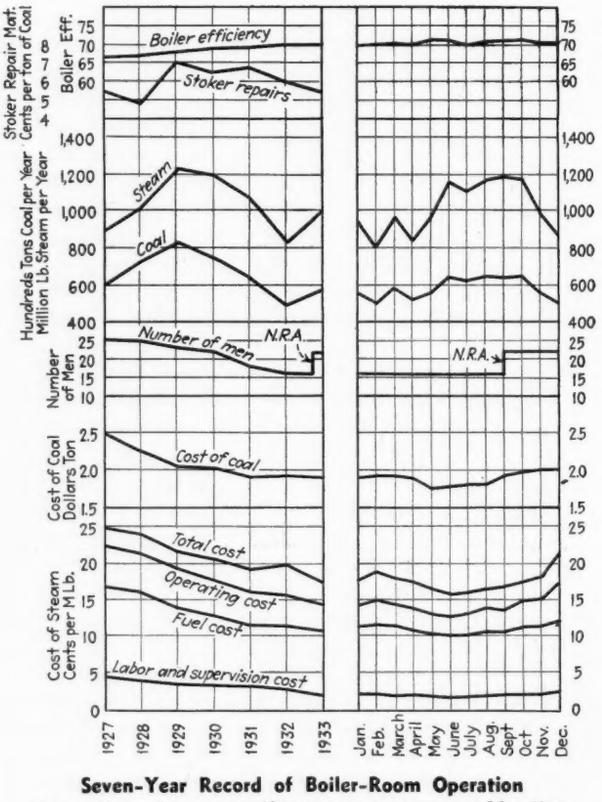
Modernization was, however, finally considered, and it was decided to employ a plant engineer who would concentrate on problems of generation and distribution of steam and report directly to the mill manager. The program, initiated in May, 1926, has in course of time brought savings of $50,000 a year over previous operating costs. Steam costs are now so low, in fact, that an extensive modernization of this plant would hardly show sufficient saving to justify the investment.

Accompanying tables and charts show progress made with relatively small expenditures for new equipment. These results are not exceptional. In fact, an analysis of the tabulated data will show many costs that are higher than they should be, but there has been a progressive improvement all along the line. The result is that a plant which at first glance looks rather ancient, is now producing steam at a cost of less than 19 cents per thousand pounds, as compared with about 25 cents before. Reasons for the improvement are so many and so interrelated that it is impossible to evaluate each accurately.

During the first few months progress was slow. The boilers were badly scaled inside, only hand lances were available for soot blowing, and baffles on two of the larger boilers were so badly broken down that flue-gas temperatures ran as high as 750 deg. Installation of monolithic baffling reduced this temperature to 600 deg. and less. Daily gas analysis with the Orsat formed the basis of an attempt to improve firing methods, regulate dampers properly and reduce excess air.

The firemen were not exactly antagonistic to the new program, but during long years of operation maintenance of proper steam pressure had been almost the sole criterion. This fact, coupled with their almost utter lack of understanding of combustion principles, made progress difficult.

As records were accumulated and tests made, it became possible to back up with reliable figures the requests for soot blowers, boiler meters, a water softener and ash-handling equipment. At the same time it was



Seven-Year Record of Boiler-Room Operation

Steam shown is net quantity to power, process and heating, after deducting steam for boiler auxiliaries in feed-water heating.

INDUSTRIAL STEAM PLANT

HE SAVES $50,000 A YEAR

By A. S. WELLS

pointed out that the plant was so heavily loaded 24 hr. per day that capacity of all eight boilers was required. Major repairs could be made only on Sundays.

About this time plans for greatly increased production in the mill made it necessary to provide more capacity, so two 6,000-sq.ft. second-hand boilers were purchased. These were 10 years old, but with complete overhauling and provision of multiple-retort stokers, they made satisfactory units. In June, 1928, these boilers, together with the requested soot blowers, boiler meters, ash-handling system and water softener, were in service. Steam requirements had meanwhile increased about 60,000 lb. per hr., making a total of 197,000 lb. per hr., but there was still sufficient reserve so that any one of the eight old units could be taken out of service at any time, so a campaign of overhauling was started.

At the same time this additional capacity gave an opportunity to experiment with various grades of coal. Within a few months a coal was found which had higher heating value and at the same time could be delivered to the plant for 17 cents less per ton, due to a lower freight rate. Its lower ash softening temperature caused some difficulty and increased stoker repairs somewhat, as shown in the curves, but the net result in steam costs was distinctly favorable. Analyses of the two coals are:

	Coal No. 1 Per cent	Coal No. 2 Per cent
Moisture	3.75	0.95
Volatile matter	32.63	30.45
Fixed carbon	49.96	59.54
Ash	13.66	9.06
Sulphur	0.95	0.89
B.t.u. per lb. dry coal	12483	14002
Ash-softening temperature, deg. F.	2800	2400

As boilers were gradually worked into better condition, and boiler meters became available, more serious attempts were made to interest firemen in improved firing methods. For several weeks, as an incentive, charts were carefully checked each day, marked by shifts with fireman's name, rated excellent, good, fair or poor, and hung on the bulletin board in the boiler room. It was necessary for some time to maintain the old schedule of turbining boilers every sixty days, but as the scale gradually worked loose, due to action of the soft water, the turbining schedule was increased to once in twelve months. Soot blowers, of course, maintained a much cleaner condition of tube exteriors, and their combined action reduced flue gas temperature.

Boiler maintenance costs, particularly for tube renewals, also gradually decreased. Maintenance cost records on individual pieces of equipment showed that the old plunger-type boiler feed pumps were a continuous source of expense, due to their high-speed operation and generally worn-out condition. A 500-g.p.m. turbine-driven centrifugal pump, which had been picked up from another division of the company, soon showed a large saving which made it possible to obtain an appropriation for a duplicate new unit. Savings in repairs, after several years with these new

MONTHLY STEAM PLANT REPORT

	Item	Current Month Total Cost	Current Month Unit Cost	Cumulative Total Cost	Cumulative Unit Cost
1	Labor and supervision	$1,994.48	0.0261	$8,557.09	0.0269
2	Repair material	709.42	0.0093	3,133.38	0.0097
3	Lubricants	30.50	0.0004	113.11	0.0004
4	Supplies	206.77	0.0027	851.75	0.0027
5	Fuel	8,795.80	0.1153	36,343.61	0.1141
6	Total operating expense	11,736.97	0.1538	48,998.94	0.1538
7	Fixed and indirect expense	2,544.72	0.0334	10,759.38	0.0338
8	Total expense	14,281.69	0.1872	59,758.32	0.1876

Monthly Performance Data

9	Total water evaporated — Metered less blowdown	85,500,000
10	Tons coal burned	4,574
11	Net steam delivered to mill for power and process	76,257,000
12	Steam pressure	150
13	Feed-water temperature	205
14	Actual evaporation	9.35
15	F. & A. evaporation	10.36
16	B.t.u. value of coal as fired	14,200
17	Boiler efficiency	70
18	Normal load, boiler hp.	5,000
19	Numbers of boilers in service	8
20	Rated hp. of boilers in service	3,160

Remarks. — Mill operating rate 5 days per week.

STEAM PLANT COSTS, 1927 TO 1932

ITEM	1927	1928	1929	1930	1931	1932	Variation 1932 vs 1927
Labor and supervision	$36,562.15	$39,570.93	$42,467.90	$39,238.92	$32,621.77	$23,099.01	$13,463.14 — 36.8%
Repair material	9,483.95	9,348.72	17,826.02	13,237.87	10,673.43	7,846.67	1,637.28 — 17.3%
Lubricants	794.02	967.62	732.39	741.34	488.01	298.02	496.00 — 62.4%
Supplies*	870.53	2,173.35	3,975.79	3,472.11	2,708.29	2,308.67	1,438.14 +165%
Fuel	149,222.87	165,556.49	170,148.93	152,817.66	121,927.40	94,089.01	55,133.86 — 37%
TOTAL	$196,933.52	$217,797.11	$235,151.11	$209,507.89	$168,418.80	$127,641.37	$69,292.15 — 35.2%
Fixed and indirect†	22,702.59	25,559.58	28,238.52	33,878.27	36,729.80	33,650.31	10,947.72 + 48.2%
TOTAL	219,636.11	243,356.69	263,389.63	243,386.16	205,148.20	161,291.68	58,344.43 — 27.8%
Fuel — tons	60,042	73,673	83,442	75,072	64,193	49,023	21,019 — 35%
Fuel — price	2.487	2.240	2.039	2.036	1.900	1.919	0.568 — 22.8%
M lb... steam‡	895,928	1,028,387	1,227,369	1,196,388	1,072,528	821,853	74,075 — 8.3%
Operating cost, $/M lb	0.2210	0.2117	0.1915	0.1751	0.1590	0.1553	0.0657 — 29.7%
Total cost, $/M lb	0.2450	0.2370	0.2145	0.2034	0.1910	0.1962	0.0488 — 19.9%

*Increase in cost of supplies due to chemical for water softener.
†Increase in fixed charges due to new investment and to an arbitrary increase of charges against old investment.
‡This is net steam delivered to the mill.

pumps, were shown to be over $2,000 a year. Other items of excess cost were also brought to light as records accumulated.

The ash-handling system finally chosen was the hydraulic sluice by means of which ashes are flushed from individual ash pits to a sluice trough leading to a clinker grinder and pump pit. Ash is then pumped to an overhead bin for dumping to trucks or railroad cars. This is a tremendous improvement over the former method of shoveling ashes from pit to wheelbarrow and so on out to a pile in the yard. The basement was transformed into a livable working space and ash-handling labor reduced from two men per shift, or a total of six men, to one man part time during the day shift. Basement floor drainage had been handled by a steam-jet siphon which elevated water to the level of the mill sewer. This jet had been used apparently because it was simple and gave less trouble than a motor-driven pump. As it was in service practically 24 hours a day, the investment required to enlarge the sump pit and install a motor-driven pump was returned in less than a year's time.

Simultaneously with this work at the boiler plant, campaigns were carried on out in the mill to accomplish more economical use of steam for heat and process, eliminate waste of hot water, divide load properly on the turbines and reduce use of live steam where extraction steam would be as effective. During one period of about three weeks a dozen small wastes were discovered and eliminated, with a consequent coal saving of about $40 a day. All in all, over a period of years, this campaign for economical use of steam resulted in a saving of at least $15,000 a year.

The monthly power report shown is a typical one and indicates an over-all boiler efficiency of 70 per cent. This compares with a figure of about 65 per cent before the campaign for economy. The cost of steam, it should be noted, includes overhead charges and is based on actual steam delivered to the mill for power, process and heating, steam used in the boiler plant for auxiliaries not being figured as boiler-plant output. The general trend of steam production, efficiency and cost over a six-year period is shown in the chart, Fig. 1, further elaborated in the accompanying table.

This investment in more active supervision of a steam plant has been profitable, for on the basis of the records, and after making due adjustment for a general fall in prices, there still remains credited to the steam plant engineer a saving to the company of about $50,000 a year.

PREHEATING

APPLIED TO AIR CONDITIONING

By ANDRÉ MERLE
Clyde R. Place, Engineers

IN THE design of an air-conditioning system, one of the first points to be decided is the minimum amount of fresh air for the summer and winter season. A careful survey has brought to light the fact that economy of operation has been more than a deciding factor in the determination of minimum fresh air quantities. There are numerous installations that handle but 7½ cu.ft. of fresh air per person, approximately 15 per cent of the total amount of air supplied and 35 per cent of that dehumidified. As all of the fresh or outside air passes through the conditioner, it is here that the importance of preheating and humidifying is brought forth.

The temperature of fresh air during the winter season, varying as it does from zero to 30 deg., is much too cold to be passed through the water sprays of the humidifier. It must be preheated to prevent the water from freezing and also to maintain a predetermined temperature after its mixture with return air so that it may absorb and carry the correct amount of moisture. The desired amount of humidity is best obtained by controlling the average temperatures of the preheated fresh and return air mixture instead of heating the water spray, as this has been found to impart an odor to the water and air.

In passing through the humidifier, the air will give up some of its heat to evaporate water and will leave saturated with water vapor at the temperature of the recirculated spray water. The temperature attained by the spray water depends upon the temperature and humidity of the entering air mixture. The problem then is to determine the temperature to which the air must be heated in order to obtain the humidity required after the air leaves the water sprays. This can be done by determining the temperature to which the air must be heated, in order that its total heat will be the same as the total heat in the air leaving the humidifier and with the desired temperature and moisture content. Under these conditions the sensible heat in the air above the leaving temperature is just sufficient to evaporate enough water to saturate it at the leaving conditions. Since all of the heat comes from the air, spray water will not be heated or cooled.

The required average temperature entering the air conditioner can be found easily by using psychometric charts as illustrated in the following example:

Assume it is desired to air-condition an office building. The guarantees state that for winter conditions of 0 deg. outside temperature indoor conditions of 70 deg. dry bulb and 40 per cent relative humidity shall be maintained. This corresponds to 56 deg. wet bulb and 45 deg. dew point. The total air supply required is 100,000 c.f.m., of which 16 per cent, or 16,000 c.f.m. is to be fresh air and must be preheated.

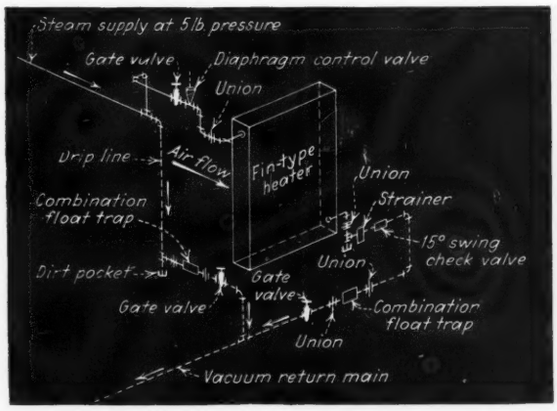
The air leaving the humidifier should have a dew point of 45 deg., and since it will be saturated it will have a total heat of 17.5 B.t.u. To find the temperature to which the fresh air should be heated, follow down the 45-deg. wet-bulb line until the moisture content of the entering air is reached. The dry-bulb temperature corresponding to this point is the temperature to which the fresh air should be heated.

Zero-degree outside air can safely be assumed dry. In winter operation the fresh air constitutes about half of the air flowing through the air washer, the other 50 per cent being returned air. This air will return at a temperature of 70 to 72 deg. and relative humidity of, say, 40 per cent and mixed with preheated fresh air.

Since the fresh air is practically dry, the resulting mixture will contain about 24 grains of water vapor per pound of dry air. The intersection of the 45-deg. wet-bulb line with this moisture-content line gives a dry-bulb temperature of about 58 deg. as the temperature of the mixture entering the air washer, with a total heat of 17.5 B.t.u. per lb. The fresh air must be heated to $(58 \times 2) - 72 = 44$ deg. to give a mixture temperature of 58 deg.

To take care of heating-up conditions it is generally assumed that the return air is also dry. The dry line and the 45-deg. wet-bulb line intersect at 73 deg. so that for heating-up conditions the fresh air should be heated to 73 deg. It is for this condition that the preheaters should be designed.

The next step is to choose the size and type of heater. Knowing the rise required (73 deg.), refer to a manufacturer's catalog to obtain the number of



rows of depth and type of surface necessary to produce and maintain the required temperature rise with 5 lb. steam pressure.

In comfort air-conditioning installations, such as office, buildings, banks, theaters, stores, etc., more than three rows of fin heaters or equivalent cast-iron heaters are seldom required. Care must be taken when using manufacturers' catalog data, as fin-tube heaters are rated in net free area, which is approximately half the face area of cast iron. Air velocities of 500 to 700 ft. per min. are preferred with fin-type heaters and 1,000 to 1,400 ft. per min. with cast iron. The static fan pressure required is about the same with either type.

A fin-type heater catalog shows that, at an air velocity of 600 ft., two rows of fin-type tubes will raise the air temperature from 0 to 82 deg. As only 73 deg. rise is required, it is necessary to by-pass some of the fresh air around the heater. The quantity of air to be heated is $\frac{16{,}000 \text{ c.f.m.} \times 73}{82} = 14{,}300$ c.f.m. The free heater area required for 600-ft. velocity is $\frac{14{,}300}{600} = 24$ sq.ft.

The air by-passed will be $16{,}000 - 14{,}300 = 1{,}700$ c.f.m. The size of the by-pass depends upon pressure drop through the heater. Practical methods assume 1,100 to 1,250 ft. per min. as the velocity through the by-pass. The area of the by-pass is then $\frac{1{,}700}{1{,}100} = 1.5$ sq.ft.

Due to control requirements the fresh air heaters are split into two or more rows or sections deep. The first row (0- to 36-deg. rise) is usually on a quick-acting thermostat or hand control. The second row (46-deg. rise is connected to the wet-bulb or dew-point control at the humidifier. The control on the first row prevents spray freezing, and that of the second row controls humidification.

The next step is to choose the proper size and type of heaters from the manufacturer's catalog to produce the designed conditions. From the tables of physical data in the manufacturer's catalog we find there will be required 4 units, 2 units of the preheating type (36-deg. rise) and 2 units of the reheating type (46-deg. rise). Each unit will be one row deep with tubes 4 ft. long. They will be set two high and two deep.

In the design of steam piping to and from fin heaters use a velocity of 6,000 f.p.m. Table 1 provides a quick means for choosing proper-size pipes for known quantities of condensation. A variation of approximately 10 per cent from the table is permissible. It is best to increase the pipe to the next size larger rather than to cut down and increase friction. Great care must be taken to secure the proper type traps. Due to sudden loads, float, bucket or combination float and thermostatic type traps should be used. Straight thermostatic traps for this service ordinarily lack capacity and should not be used, except for air vents on return.

Diaphragm control valves generally are chosen to handle steam at a velocity of 9,000 f.p.m., whereas the steam supply system is designed for 6,000 f.p.m. at 5-lb. pressure. With these velocities, steam control valves are usually one pipe size smaller than steam supply.

Table I—Pipe Size For Blast Heaters

VELOCITY OF STEAM 6,000 F.P.M.

Steam lb. Per Hour	Supply	Gravity Return	Vacuum Return	Steam lb. Per Hour	Supply	Gravity Return	Vacuum Return
200	1¼	1¼	¾	1,600	4	3	2
400	2	1½	1	2,200	5	3½	2½
600	2½	2	1¼	2,600	5	3½	2½
800	3	2	1½	3,200	6	3½	2½
1,000	3½	2½	1½	3,600	6	3½	2½
1,200	3½	2½	1½	4,200	7	4	3

5 lb. per sq. in. Steam Pressure. 100 ft. Length of Run.

Table II—Diaphragm Control Valve Size

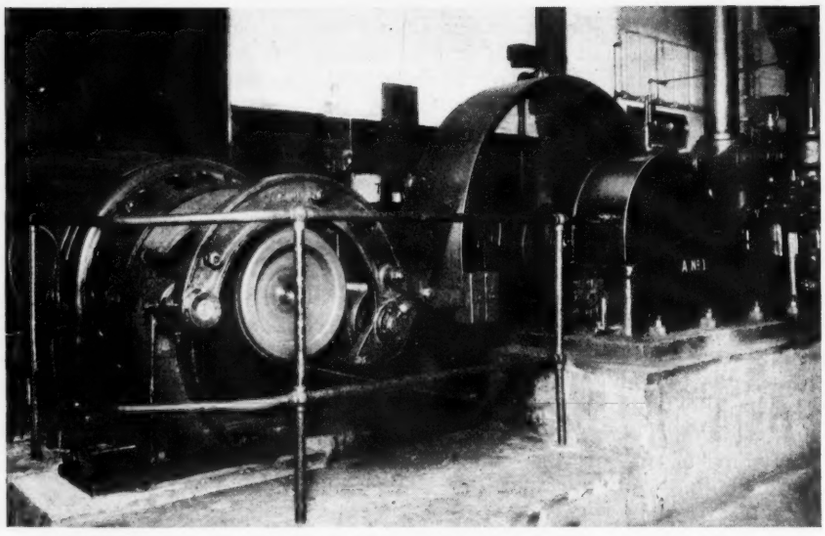
(DIRECT-& REVERSE-ACTING TYPES)

Steam lb. Per Hour	Size of Valve	Steam lb. Per Hour	Size of Valve
01 — 20	½	601 — 700	2½
21 — 40	¾	701 — 800	2½
41 — 60	¾	801 — 1,000	3
61 — 80	¾	1,001 — 1,200	3
81 — 100	1	1,201 — 1,400	3
101 — 120	1	1,401 — 1,600	4
121 — 160	1	1,601 — 1,800	4
161 — 200	1¼	1,801 — 2,000	4
201 — 300	1½	2,001 — 2,400	4
301 — 400	2	2,401 — 2,800	4
401 — 500	2	2,801 — 3,200	5
501 — 600	2	3,201 — 3,600	5

5 lb. per sq. in. Steam Pressure. Steam Velocity 9,000F.P.M.

A power-transmission engineer of broad experience tells how to modernize drives

FLAT-BELT POWER LOSSES



A 150-hp. motor connected to an ammonia compressor by a short-center belt drive with idler

AND HOW TO REDUCE THEM

By ROBERT W. DRAKE
Consulting Engineer, De Kalb, Ill.

OLD-TIME mechanical power-transmission systems lost 35 to 60 per cent of the power leaving the engine flywheel, when operating under normal load. The lower figure applied where individual machines required 5 to 15 hp., the higher to small machines. Electric transmission reduced these losses to around 25 to 45 per cent. In group drive these losses are about equally divided between mechanical and electrical. With individual motor drive the total losses remain about the same, but the greater portion is electrical. Further improvements in power transmission have made possible an additional saving of 10 to 15 per cent of the total power used.

At one time it was generally believed that about 90 per cent of mechanical power-transmission loss in group drives was bearing friction. Gradually engineers have come to realize the importance of belt and pulley windage, belt creep and slip and belt bending.

Losses in babbitt hanger bearings may be reduced 25 to 75 per cent by the substitution of anti-friction bearings, depending on type of bearing used. All types of anti-friction bearing reduce starting friction more than these figures indicate. An intelligent choice from the three types of anti-friction bearings available depends upon local conditions under which the drive is used. Ball bearings and tapered roller bearings, although they are the most efficient, cannot be split—they must be slipped on the shaft. Split spiral-roller bearing assemblies are available which materially reduce installation cost on existing shafts, or of subsequent installation changes. The latter is important where frequent relocation of heavy machines is necessary. Anti-friction bearings greatly reduce oiling cost, since they require oiling only one to four times per year. If not over-lubricated, they will not drip oil, which is important in many applications.

No change in mechanical transmission details will show a more immediate saving in maintenance expense than will substitution of anti-friction bearings in loose pulleys formerly operated with sleeve bearings. It is seldom realized what repair costs of old-fashioned countershafts with loose pulleys amounts to unless detailed records are kept.

Where belt speeds are low, pulley windage is not important in drive losses. This loss increases from four to eight times each time rim speed is doubled. The low figure is for wide pulleys of relatively small diameter. It is evident that pulley-windage losses may be of serious proportions where belt speeds are high. On such drives, power savings obtained by replacing large high-loss pulleys with low-loss designs may pay for the change in less than a year. Pulleys that have high losses at high speed may be used where they will operate at rim speeds of 600 to 2,000 ft. per min., at which speeds their windage losses will be negligible. A high windage-loss pulley is one that has spokes shaped so that they will develop a high atmospheric fanning action.

Windage losses of a high-loss pulley may be reduced 50 to 75 per cent by housing its spokes as in Fig. 1. Such a housing does not reduce the losses of a low-loss pulley sufficiently to warrant its installation. It is advisable to make the sheet-metal disks in one piece to prevent the possibility of their separating and flying off. A good fit at the outside edge is necessary to prevent loss due to leakage as in Fig. 2.

It is usually more satisfactory to replace a high-loss pulley operated at high rim speed with a low-loss type

and use the old pulley at a lower speed when opportunity offers. Housing the spokes of expensive large-size pulleys for which further use is unlikely may be a logical solution. Substituting a low-loss pulley for, or housing in the spokes of a high-loss one 70 in. in diameter by 12 in. face operating at 275 r.p.m., will save over 2 hp. in power losses. This will reduce power costs $40 to over $100 per year depending upon cost of power and hours operated. This is an extreme case, a very bad pulley operated at a very high speed.

Fig. 1—Correct way to inclose the spokes of a pulley to reduce windage losses. Fig. 2—Space between pulley rim and the spoke inclosure permits air circulation and causes windage losses. Fig. 3—Load graph of a 35-hp. motor driving a group of 22 machines

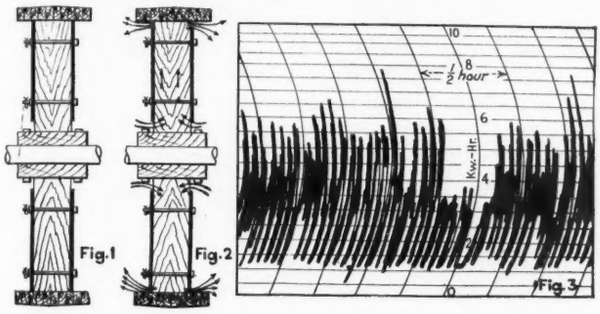
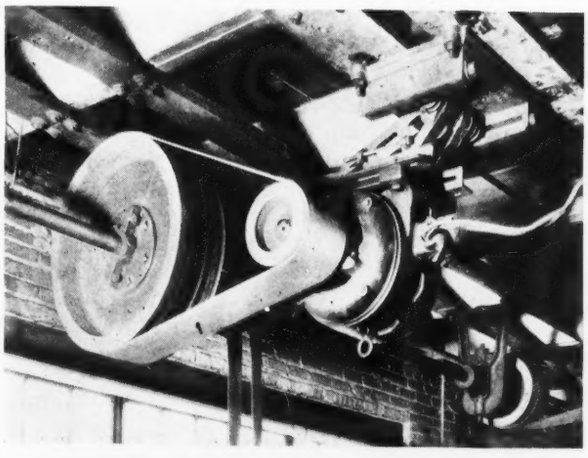
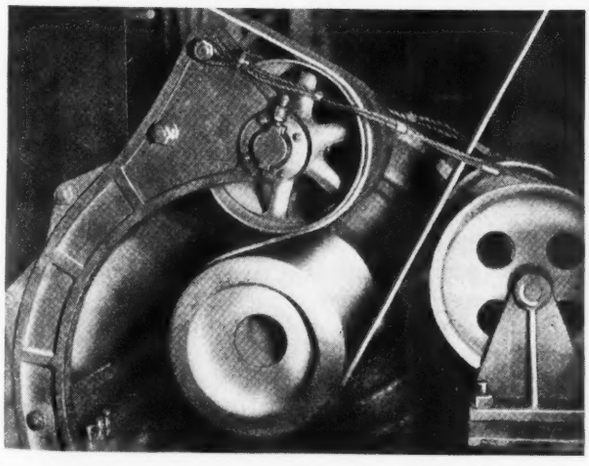


Fig. 4 (Below)—Pivoted-base motor drive automatically maintains belt tension. Fig. 5 (Bottom)—Where it is difficult to obtain a satisfactory design for a vertical belt, an idler pulley will improve operation





Housing in a 6-spoke cast-iron pulley of usual design would scarcely reduce losses.

Loss due to turbulence set up by belts in the surrounding air increases approximately as belt speed squared. It has been generally believed that the most economical belt speed was around 4,000 to 4,500 ft. per min., a conclusion based upon the load-carrying capacity, cost, and life of belting. Present knowledge of windage losses in pulleys and belting shows that the most economical belt speed varies with proportions of the drive, and is nearer 2,000 than 4,500 f.p.m.

Windage loss of a light double belt is 30 to 40 per cent less than for a single belt proportioned to transmit equal power at the same belt speed, because a double belt has 30 to 40 per cent less width and surface of contact with the surrounding air. Thus, if the smaller pulley diameter of the drive permits, a light double belt is preferable to a single, particularly at high speed. For slow speeds, the difference in windage losses between a single and an equivalent light double belt is negligible, but for high-speed belts the saving possible by using the latter is worth while.

For example, the difference in windage losses between a heavy single belt 8 in. wide and a medium double belt 5 in. wide operating on 20-ft. pulley centers at 5,000 f.p.m. running 3,000 hr. per yr., where power costs 2c. per kw-hr., will amount to $10 per year. Short-center drives with tension mechanically maintained by a pivoted motor base, or by means of an idler of ample diameter properly located, have low windage loss because the belt is short and presents a comparatively small surface to the air.

In some installations where maintenance has been haphazard, a moderate expenditure in labor to eliminate the losses due to idle machine belts dragging $\frac{1}{8}$ to $\frac{1}{4}$ in. on tight pulleys, belts rubbing on shifter forks and to other similar conditions will make an astonishing reduction in power consumption.

All belts stretch a little when first installed. A new belt requires one or two take-ups to remove the initial stretch after it has been in service for a while. Once this initial stretch is removed, a moderately loaded belt will hold the tension necessary to assure operation without slip for a long time.

When selecting a belt, load peak and not average load must be the guide. A belt of sufficient width to carry the average load only, without slippage, may slip badly during peaks. If we try to eliminate slip during maximum load by tightening, the belt will stretch and frequent take-ups will be necessary. Belt life will be materially decreased and maintenance expense incurred.

Even when slip is eliminated by proper design and maintenance, the belt will creep a little, whether it is made of leather, rubber, canvas or balata. Creepage varies with load, belt, elasticity and other factors. For conservatively loaded leather belting creepage is about 0.25 to 0.33 per cent at average load and 0.5 to 0.75 per cent at peak loads.

Unless the drive is carefully planned, belt slip is likely to be the largest single loss in group drive. In such a drive there are ordinarily three belts between the motor and driven machine, motor belt, countershaft belt, and machine belt.

Power consumption of most group drives varies greatly, as in Fig. 3. Many belt drives are designed so that they have 1 to 1.5 per cent slip in each belt at average load. During load peaks such a belt may slip

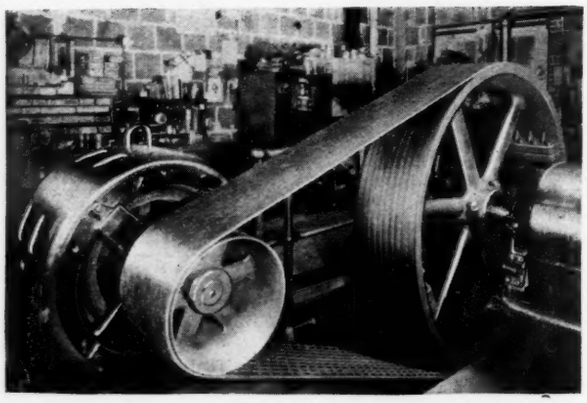


Fig. 6—A 125-hp. motor connected to a compressor by a high-coefficient of friction belt operating on a short-center drive

4 per cent, or approximately 12 per cent for the three belts between motor and driven machine. A check made with an ordinary speed counter does not show so great a drop in speed with load, for it gives average speed over a period. An indicating tachometer or a magneto tachometer will, however, show the momentary drops. Such fluctuations in speed decrease output and may seriously affect quality of product. In more than half the cases which I have investigated the increased production that could be obtained by eliminating belt slippage would pay a handsome return upon the cost of a drive of sufficient capacity for the peak loads.

Generally the best way to eliminate belt slip is to design all belt drives of sufficient capacity to drive even peak loads without slip. A short-center drive from the motor to the groupshaft of a type such as the pivoted motor base drive that automatically maintains desired belt tension is a desirable combination. The gravity idler drive does much the same thing, provided an idler pulley of ample diameter is used and properly installed. A small idler pulley close to the motor pulley has a slightly higher capacity, but belt life is likely to be unsatisfactorily short. As compared with the pivoted-base drive, a good gravity-idler drive has the advantage of higher peak overload capacity and the disadvantages of greater creep at all loads and somewhat increased maintenance. The short belt used with these drives decreases windage losses materially.

For countershaft belts, centers are usually reasonably long and conditions are favorable for low slip if a belt of ample width is used. To keep the cost of belting reasonable, it is best to use pulleys to give a belt speed of 2,000 to 3,000 ft. per min. if this is possible. Higher belt speeds are accompanied by increased windage losses for both pulleys and belts and are not recommended except when the driven machine speed is so high as to require them. Where space considerations force somewhat less conservative countershaft belt sizes than are desirable, a paper driven pulley on the countershaft will help. So will a paper pulley on the lineshaft if this pulley does not have twice the countershaft pulley diameter. Split paper pulleys up to 48-in. diameter, paper rims, metal spokes, have been available for some years.

Of all drives, a vertical or nearly vertical belt to a machine should be of ample width and should not be too long. If the driven pulley of the desired width cannot be used, pulley diameters should be increased to increase belt speed and power transmitted. Belt speed should not be over 4,000 ft. per min. Larger pulleys will also permit a thicker belt to be used.

Belt strength is more troublesome in vertical drives than in almost any other, because the slack tends to accumulate at the lower pulley and destroys belt adhesion on that pulley. Double-belts stretch much less than single belting and should be used for vertical drives if the diameter of the smaller pulley will permit. A so-called combination-tannage belt will help decidedly. This belting grips the pulleys better than ordinary oak-tanned belting, and does not have to be run so tight to carry the load. It increases capacity 10 to 20 per cent as compared with an ordinary oak-tanned belt of the same width and thickness. Straight mineral tannage leather will do the same thing, but some of these belts have had unsatisfactorily short lives. This has given the whole class a bad name with some users.

Several manufacturers make belting with the two plies, waterproof cemented under tension. The initial stretch of such belting is somewhat less than for that made by more usual methods. This belting has advantages when a new belt must be installed on a heavily loaded fixed-center vertical drive where even a little slack is bound to cause slippage. Where it is difficult to obtain a satisfactory design for a vertical belt, an idler may be used and should be at least as large as the smaller pulley of the drive. If this is small for belt thickness, then the idler pulley diameter should be larger, to give increased belt life.

Idler pulleys should never be crowned and should be away from the adjacent live pulley by a distance equal to at least belt width. The idler is best located near the smaller pulley of the drive. If this cannot be done, an idler located near the larger pulley will maintain the desired tension just as well, but the belt will not have so complete a wrap around the small pulley.

I have been told "but we can't use idlers on machine belts, there are so many of them." I have tested a room containing 34 identical machines. In this case simple arithmetic proved that power savings alone would pay for idlers on every machine belt in 18 months; increases in production would pay for them in less than three months, and the improvement in quality and decrease in spoilage of product would materially shorten this time.

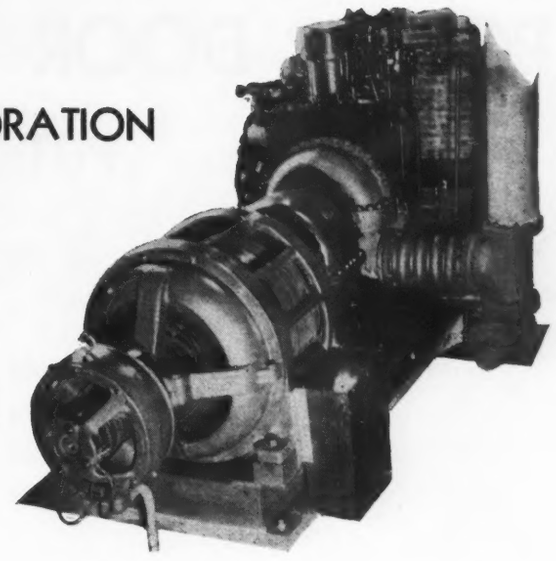
HEATING ALL OUTDOORS—In spite of years of educational work showing the cost of such waste, many industrial establishments are still industriously attempting to heat all outdoors. As the police commissioners say, "You can't win," but some people *will* keep on trying. Here are a few examples:

A plant located where the temperature falls to 27 below zero uses large stills to make acetic acid from wood. Some of these stills operate out in the open in this sub-zero winter. Citizens up there wear overcoats, but the stills belong to a nudist colony.

In the same climate is a company drying enameled woodenware in very large ovens. The two end walls and one long wall are brick, but the front is a continuous series of steel doors without insulation. High-pressure steam pipes running to the bottom of the oven are also without insulation. Not only does this waste a great deal of coal, but the product is not uniform.

HYGRADE FOOD PRODUCTS CORPORATION

SKIMS 200 KW. FROM PURCHASED STEAM



IN A steam power plant without boilers the Hygrade Food Products Corporation's Chicago packing house generates continuously around 200-kw. The entire steam supply of the plant, for both power and process, comes from a nearby central station. Moreover, the local turbine-generator is paralleled with utility current.

Sausage, lard, and canned meat are the chief products of this old packing house, purchased by Hygrade about ten years ago. The steam plant contained five water-tube boilers, totalling 12,000 sq.ft.; two engine-driven, 125-ton, ammonia compressors and one motor-driven unit of 300 tons.

The boilers, installed in 1905, reached a condition last summer where retubing was imperative. Stokers and settings also needed repairs. Since the total cost of all these changes would have been $20,000 and would have prolonged the life of the old equipment only a few years, they did not seem worth while. As an alternative, a modern boiler plant was studied, but was also rejected as involving a greater investment than was advisable under existing financial conditions. There remained a third possibility—the purchase of all steam. This was adopted. From the central station 800 ft. away an 8-in. underground steam line conveys steam at 200-lb. pressure and 150-deg. superheat to the Hygrade property. Within the property line, the steam pipe is raised and carried on steel poles into the engine room.

Wide-Range Turbine

The turbine installed to generate by-product power from this steam will operate under a wide range of conditions. Present initial pressure of 200 lb. can later be increased to 400 lb. if a new boiler room is installed. Back-pressure is around 90 lb., but may range anywhere from 10 to 100 lb. with this turbine. The generator guarantee is good for 300 kw., although present steam conditions will give only 200.

This machine, in use for four months, has sectional valve gear, and is supplied with both back-pressure and speed governors. Normally the unit operates with a back-pressure governor and in parallel with the central station. However, should the central station service be interrupted, the unit can be operated independently on the speed governor.

When the turbine operates with the back-pressure governor, exhaust is first delivered to the old engine-room header at approximately 100 lb. to operate the steam-driven compressors. Because of varying condenser pressures, this steam is slightly higher in summer than in winter.

Process steam demand of the plant is often 30,000 lb. per hr., with a 38,000-lb. peak. Only 20,000 lb. can flow through the turbine. The difference is supplied through a reducing valve, mixing with the exhaust of the turbine, which reduces its superheat. An auxiliary outlet on the exhaust side of the turbine has been provided with the idea of supplying 45-lb. steam to the lard-rendering department only.

The governor is of a type permitting the back-pressure setting to be changed with the machine operation. It is, of course, essential that the reducing valve discharge pressure be varied with the back-pressure governor. For this reason, a type of valve was selected with which the pressure can be adjusted positively by changing weights on a lever arm 3 ft. above the engine room floor. The valve is 15 ft. above the regulator.

While steam is bought at a price higher than that for which a modern boiler plant of this size could make it, the continuous 200-kw. supply of by-product power will, it is expected, compensate for the increased steam cost. As already indicated, construction of the turbine will permit its operation at 400 lb., if a modern boiler plant should later be installed.

The turbine is a General Electric machine, geared to a 3-phase generator operating at 1,200 r.p.m. The reducing valve is of compressed-air-actuated type, made by Hagan Corporation. The switchboard panel for the new unit was built by Marquette Electric Switchboard Co. and is equipped with an I.T.E. circuit breaker and Weston instruments. Engineroom piping was fabricated by Crane Co. and installed by Hygrade. W. L. Fergus & Co. were engineers in charge of the installation.

POWER DOOR OPERATORS

PUT PEP IN ELEVATOR SERVICE

By F. A. ANNETT
Associate Editor

With high-speed cars, automatic door operators become a necessity. Here are described the various types of electric car and hoistway door operators

HIGH-SPEED elevator service demands and is dependent upon corresponding high-speed car and hoistway-door movement. This means that these doors must be power operated. Totally inclosed elevator cars make necessary power-operated doors with their controls tied into those of the machine. To obtain highest efficiency in elevator operation, hoistway doors must also be power operated and move in synchronism with the car doors. When elevators are made full-automatic at least the car doors must be power operated and open and close automatically as the car stops or starts. For these and other reasons, rapid advances have been made during recent years in applying power operators to elevator doors.

Practically all earlier types of power operators were compressed-air engines, but modern operators are electrical types, usually motor driven. There are two general classes: one where individual operators are applied to car and hoistway doors, the other where a single operator handles both car and hoistway doors.

Fig. 1 shows a simple car-door operator, consisting of a motor M connected to a worm gear W which is attached to the car doors by a crank and a system of arms and levers. Operating arm A is fulcrummed at F and connects to the doors at D_1 and D. A connecting rod attaches the top end of arm A to the crank on the operator. When the crank is driven in a clockwise direction, movement of arm A around its fulcrum opens the doors by passing one behind the other and moving them to the left. Reverse movement of the operator closes the door.

Control of the door operator is tied in with that of the elevator. As the car stops at a floor, a circuit is completed which causes the operator to open the doors. Movement of the car-operating switch to either the up or down position completes a closing circuit for the door operator. Returning the car-operating switch to the off position before the doors are closed will cause them to open again. This is a safety device which prevents injury to passengers entering the car as the doors start to close. This protection may be obtained automatically by focusing one or more light beams across

Fig. 1—Simple motor-driven operator for opening and closing car doors

Fig. 2—Individual motor operator for opening and closing hoistway doors

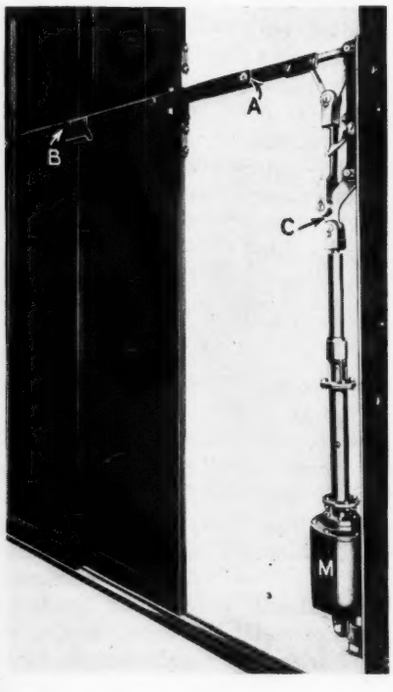
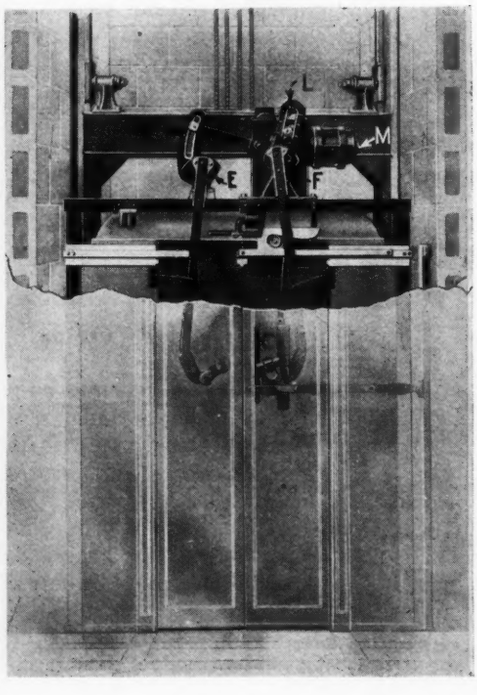


Fig. 3—Single operator that opens and closes car and hoistway doors



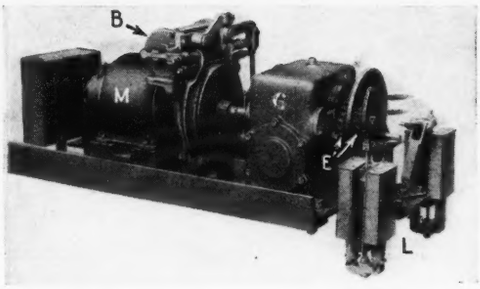


Fig. 4—(Left, top)—High-speed, electric door operator consisting of motor, brake, worm gear, two eccentrics and limit switches

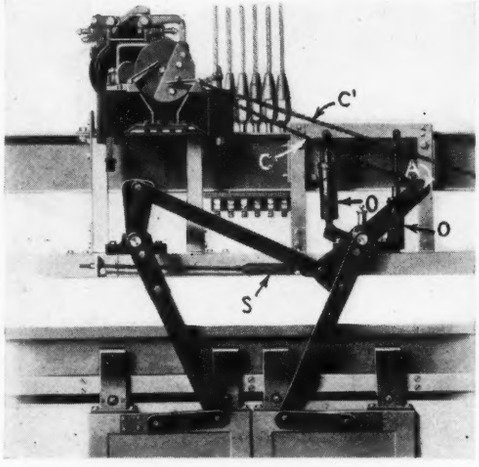
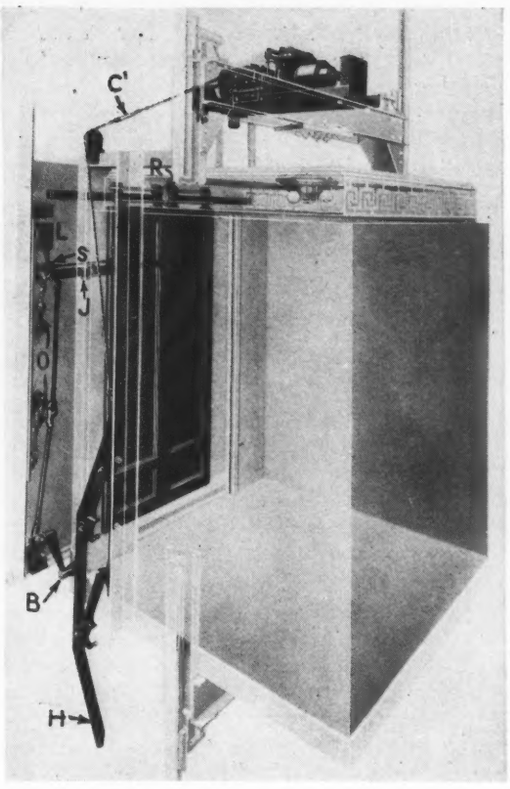


Fig. 5 (Left)—Operator, Fig. 4, connected to single-speed, center-opening car doors

Fig. 6 (Right)—Connection of operator, Fig. 4, to single-speed, center-opening hoistway doors



the elevator entrance on photo-electric cells connected into the door-control circuit. Should a passenger step into the path of the doors after they start to close, they will immediately stop and reopen. The doors can be closed only when the light beam is not interrupted.

Car movement is interlocked with door position so that the car cannot start until the doors are closed. A control panel in the elevator machine room manipulates the door operator and holds its control circuits until the doors are fully closed or opened. Upon approaching either open or closed position, motion of the doors is retarded by a dynamic-braking action of the operator motor, thus preventing door slamming. In case of emergency the doors may be operated by hand.

On some elevator installations, car doors only are power operated, the hoistway doors being manually opened and closed by the car attendant. This arrangement has several objections. It tends to slow up elevator schedules, because opening of hoistway doors must lag behind car-door movement, thus tending to slow up passenger movement. If a passenger starts to get off when car doors start to open, then notices that the hoistway doors are closed against him, his reaction is to stop until certain that the hoistway doors are going to open. If passengers are to leave the car quickly, openings to landings must be cleared immediately when the car stops. This can only be accomplished by having the car and the hoistway doors operate simultaneously.

One way of making hoistway doors power operated is to install an operator of the type in Fig. 2. This operator consists of a motor *M* connected by a driving screw to the door-operating bar. It requires space approximately equal to that taken by a standard semi-automatic door closer, such as those described in the April number, page 190. Control of the operator is initiated from an inductor plate mounted in the hoistway near each landing and an inductor coil carried on the car. When the car is stopping at a floor, the inductor coil is energized, causing the inductor switch to complete the door-operator circuit at that floor and the doors to open automatically. Moving the car switch to the starting position completes a circuit to close the doors. Closing of hoistway doors is under control of the car attendant until the car starts to leave the floor. These doors may also be protected with light beams and photo-electric cells, similar to those used for car doors.

When the operator motor is started to open the doors, Fig. 2, the screw connection between motor and bell crank *C* is lengthened. This causes joint *A* in the door-operating bar to break upward and *B* to move downward, and the doors move open toward the operator. To close the doors, the motor is reversed and the operating mechanism returns to the position shown. Door operation in both directions of travel is by motor power. To prevent slamming, door speed is checked near the ends of travel by dynamic braking of the motor. Reduced to its simplest form, this equipment is a power operator applied directly to a conventional type of door operator on which all oil checking devices and closing springs have been eliminated.

Several designs of elevator-door operators use a single power unit to handle both car and hoistway doors. With these designs, means must be provided to connect hoistway-door and car-operating mechanisms so that both doors move simultaneously. With the operator, Fig. 3, shown applied to two-speed, center-opening car doors and single center-opening hoistway doors, a clutch mechanism mounted on a car door at *C* transmits car-door motion to the hoistway doors so that they open and close in synchronism. The operator consists of a motor *M* mounted directly on a worm gear. The right-hand door arm is fulcrumed to the gear

case at F and the left-hand arm is pivoted at E, the whole equipment being supported from the car frame. A crank on the worm-gear shaft connects to the door-operating mechanism by a roller in link motion L. An arm extends from link L to a second link motion L' and is attached to it by a roller. The operating crank is turned in a counter-clockwise direction by the motor to open the doors. When the car doors start to open, clutch C engages a roller on the hoistway-door operating bar, and hoistway doors open simultaneously with the car doors. Full motor power is applied to start the doors and is then quickly reduced to an amount sufficient to keep them moving at a uniform speed to a point where slowdown begins. Two oil check units on the operator provide cushioning action as the doors near their limit of travel in either direction. When the car is moving up or down the hoistway, there is no contact between car- and hoistway-door mechanisms, consequently they cause no noise or wear.

With other designs of car- and hoistway-door operating equipment, the power unit opens the doors only, their closure being caused by springs. A high-speed door operator of this type is shown in Fig. 4. It includes motor M, electrical brake B, worm gear G, two eccentrics E and limit switches L. Car doors are operated by one eccentric and hoistway doors by the other. Fig. 5 shows the operator attached to the car doors. One eccentric on the power operator is connected to arm A by chain C. As the car comes to rest at a floor, the operator is energized and turns the eccentrics counter-clockwise, pulling arm A to the left. This in turn opens the car doors. When the doors have opened, power is automatically cut out of the operator and the brake applied to hold them open. When the brake is released, either by a control switch in the car or by moving the car switch to the start position, the doors are closed by spring S, which is put in tension when the doors open. Oil checks O prevent slamming of the doors insures that they will be operated quietly.

Chain C', Fig. 5, connects the operator to cam H on the car, Fig. 6. When the operator functions to open the car doors, it also raises cam H, which is thrown outward against one leg of bell-crank B mounted on the hoistway door sill. The other bell-crank leg is connected by push rods to the hoistway-door operating arm. As cam H pushes one leg of the bell-crank away from the car, its other leg causes joint J in the operating bar to bend upward and open the left-hand door to the left, the right-hand door being moved to the right by a rack and pinion connection at R. Opening the doors puts springs S in tension to close the doors when they are released. Power to open the hoistway doors is applied at right angles to the sill so that reactions from this force are taken by the door sill and flat side of the car guide, where there is practically no lost motion. Car lurching is avoided. Oil checks O prevent slamming at either opening or closing.

When the power operator is installed on self-leveling elevators, the doors open automatically as the car stops at a landing, and close with the first movement of the car switch to the start position. Opening of the doors occurs while the car is leveling, the two being so synchronized as to eliminate the passenger tripping hazard. An individual interlock L is provided on hoistway and car doors to prevent starting the car if they are not properly closed. Closing of the doors is always under control of the car attendant, and they may be stopped and reversed at any point in their travel.

Other designs of car- and hoistway-door power operators have been developed, but those described give general principles.

Assistance in preparation of this article is acknowledged to Otis Elevator Co.; A. B. See Elevator Co.; Elevator Supplies Co.; Westinghouse Electric Elevator Co., and Gurney Elevator Co.

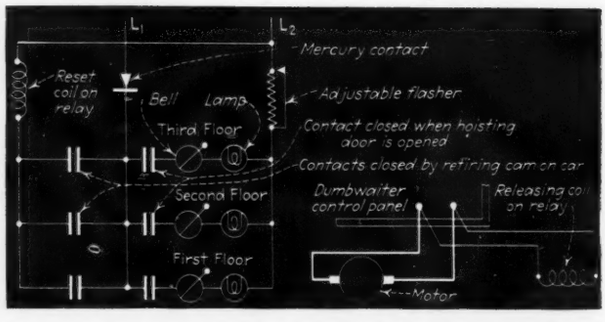
DUMBWAITER SIGNALS ITS ARRIVAL

IN ONE of the tall office buildings in downtown New York, a dumb-waiter signal system which is everything but dumb has been operating for the last year. There are no signal buttons to push, for the car automatically signals its own arrival by light and gong and keeps on signalling until someone opens the hoistway door. The signal is not given until the car has arrived, nor can the hoistway doors be opened until the car has stopped at the floor.

The system can be installed in any hoistway without interfering with operation or control. Peter J. Dugan, 14 Wall St., has been granted a patent on the system.

Here is how it works: The car is loaded at a floor and, after the hoistway door is closed, is sent on its way by actuation of the proper control in accordance with the particular system with which the installation is equipped. When the driving motor is energized the releasing relay coil shown in the figure, is also made alive and closes the mercury contact to complete L^1 and L^2 circuit.

When the car reaches the floor to which it has been dispatched, the retiring cam on the car closes the lamp and bell circuit of the floor, causing current to flow through the adjustable flasher. At regular intervals a



lamp is flashed and a single-stroke bell sounds. The lamp and bell continue to signal until answered by opening of the car door. When the door is opened the reset-relay-coil contact is closed, thus resetting the mercury contact and deenergizing the circuit lamp and the bell.

Signalling will occur at any floor at which the car stops and will continue until the hoistway door at the car is opened. Neither sender nor receiver at any floor need perform any operation other than those necessary to load and unload the car and to send it to its proper destination.

CHIEF OR EFFICIENCY MAN?

By N. T. PEF

PRACTICALLY every industrial plant can reduce wastes with the aid of an efficiency department. Yet, particularly in small plants, the cost of such a department may exceed the saving. What to do? I shall try to make a few practical suggestions.

Those who know agree that the average industrial power plant could reduce the fuel bill from ten to thirty per cent without any additional investment in equipment, other than for instruments. Simple application of well-known efficiency prinicples would accomplish this.

The main reason for neglect of efficiency in small industrial plants is the difficulty of supporting or paying for an efficiency department. Certainly some man, or group of men, must have the ability to insure efficiency and the willingness to take the responsibility for getting it, if results are to be obtained.

In many a small plant, the cost of one additional efficiency man would practically balance the savings that could be obtained. There remains one question: Could the chief engineer be the chief and the efficiency man too? Sometimes he can, but it very often happens that the chief lacks this particular capacity. As a result, his plant suffers.

Plant operation has two distinct objectives: 1. continuity or dependability of operation. 2. efficiency or economy of operation. It is a long-observed fact that these fundamentally different objectives require entirely different qualifications of the man in charge. The typical chief engineer thinks primarily of continuity or dependability of operation. He is a practical man of the mechanical type, handy with tools and able to command discipline. In contrast, the efficiency man is a theoretician; he works with books instead of with tools and he deals with laws and formulas instead of with men.

There is a third possibility. If the plant is too small for an efficiency department and if the engineer's own abilities do not run along efficiency lines, periodic surveys may do the job.

Such surveys are becoming standard practice in many lines of business, even where there is no reason to believe that any faulty condition exists. A survey is a step in the right direction. If it does not do anything else, it has a psychological effect on operators. The feeling that they are being watched is a stimulus and incentive to better effort. Many faulty conditions, obscure through custom and habit, reveal themselves to the fresh point of view of an outside observer.

Such a survey may measure the proficiency of the plant operation as a ratio of cost under best conditions to the actual power cost, the former being called the bogie or standard.

The first step is to determine the bogie—the best efficiency that can be obtained with the given equipment. The second step is to compare the bogie efficiency with the actual efficiency and the bogie cost with the actual cost. Where actual cost is much higher than standard, faulty conditions are indicated. These the survey then proceeds to locate and correct.

A bogie can be pretty closely estimated from the design of the plant, but should be checked for operating difficulties after the plant is in operation.

Incidental to the main purpose, the survey will show in what category the plant belongs, that is, what degree of efficiency service it can support. In any case, there should be a survey made to determine the standard bogie. This having been established, the actual cost or efficiency should be checked against it continually, daily or weekly. As long as a check is obtained, there is assurance of efficiency of operation. Any variation that cannot be corrected calls for another survey.

MORE WHENS AND WHYS

By THEO. J. DICK
Milwaukee, Wis.

IF YOU enjoyed the test questions last month, try these. Then compare your answers with those on page 256.

1. On what three things does the amount of linear expansion of a solid depend?
2. What is coefficient of linear expansion ?
3. What formula is used in calculating the expansion of a solid?
4. At a temperature of 60 deg. F. a steam riser is 200 ft. high. When steam at 220 deg. F. is turned on, how much will this riser expand?
5. Name one metal which has practically no expansion.
6. Why is mercury especially valuable in the construction of thermometers?
7. Does the water at the bottom of a lake get colder than 39 deg. F.?
8. Name three or more places in engineering where the expansion of materials must be provided for.
9. A suspension bridge is 7,000 ft. long. What expansion must be provided for if the temperature ranges from—40 deg. F. to 110 deg. F.?
10. Name a soft body that is denser than steel.
11. What principle is made use of in making thermostats?
12. What are the three ways in which heat may be transmitted from place to place?
13. What is the British Thermal Unit (B.t.u.)?
14. Ten pounds of water are to be heated from 44 deg. F. to 212 deg. F. How much heat is required?
15. What is specific heat?
16. What is the heating surface of a boiler?
17. A piece of cast iron weighing 15 lb. is placed in the path of the flue gases. It is then placed in 10 lb. of water at 60 deg. F. The final temperature is 150 deg. F. What was the flue gas temperature?
18. How would you determine the number of heat units given off by a substance when it cools?
19. 4,000 lb. of water at 210 deg. F. are poured into a cast-iron vessel weighing 4,000 lb. at 60 deg. F. What will be the resulting temperature of the water and the cast-iron?
20. How many heat units are required to heat 10 lb. of air at 70 deg. F. to the temperature of the fuel bed known to be 2,000 deg. F.? (Assume the specific heat of the air to be 0.24).

RUSSIANS PREFER FORMULAS

THERE are national styles in engineering as in dress. The use of steam table data gives a good example. American engineers almost always take their steam properties from steam tables. British engineers frequently use formulas to get these quantities. In both cases preference seems mainly to be a matter of habit.

National habit or style shows up again in the matter of combustion computations. American engineers have, more often than not, solved combustion problems by simple arithmetic. More recently, many of them have become interested in the short-cut "Mol" method as explained in the December, 1932 number of *Power*.

For handling the same problems, Russian engineers much prefer the use of formulas, according to B. P. Voinov, who writes to *Power* from Moscow. Mr. Voinov himself very definitely prefers formulas because "they are more accurate and can also be used by engineres who do not fully understand their derivation."

He has two objections to the "Mol" method. One is that it requires an understanding of the combustion process. The other is that the "Mol" computations are less accurate than formulas since the former assume that actual gases obey the laws of perfect gases.

He says in part: "When is it convenient to apply the "Mol" method? Only when the checked composition of flue gases is given. How may this composition be checked? By the use of corrected formulas. Will these formulas take the place of 'Mol'? At present they will not. Which method of combustion computation is most logical? The one which is as easily understood as the 'Mol' computation and admits the use of true characteristics and equations."

Pointing out that for twenty years the "Mol" method has been used somewhat in Russia for the computation of metallurgical and combustion problems, Mr. Voinov said that Russian combustion engineers do not consider it satisfactory for computation of stack-gas losses.

"Fundamental defects," he says, "in the 'Mol' method are the assumption that carbon and sulphur takes gaseous form in the flue gas and the assumption that Avogadro's law is correct."

"Actually," he says, "at 14.7 lb. and 60 deg., one pound 'Mol' of hydrogen is 379 cu.ft., of CO_2 377 cu.ft., of SO_2 370 cu.ft."

"Moreover," he says, "in using the 'Mol' method, there have not yet been worked out any mathematical equations for rapid computation. These equations are necessary for mathematical investigation of combustion computations and for checking the results of analysis of combustion products."

Space does not permit presenting Mr. Voinov's argument in detail, but he presents an actual analysis of fuel oil and fuel gas and applies formulas.

The assumed analyses and the given equations are:

Fuel-Oil Analysis (Per cent by Weight)		Fuel-Gas Analysis (Per cent by Volume)	
C	86.5	CH_4	77.6
S	0.15	C_2H_6	18.7
H	12.75	CO_2	2.3
O	0.5	O_2	0.2
H_2O	0.10	N_2	1.2
	100.00		100.0

Formula (1) (for oil)

$$\beta = \frac{2.38\left(H - \frac{O}{8}\right)}{C + 0.375S} + 0.01$$

POWER Plastograph

Formula (2) (for fuel gas)

$$\beta = \frac{0.4\,(4CH_4 + 7C_2H_4 + 0.5N_2)}{CO_2 + CH_4 + C_2H_6} - 0.79$$

In formulas (1) and (2) the letters indicate the per cents by weight and volume respectively.

Formula (3) for flue gas)

$$21 = CO_2 + O_2 + \beta CO_2 + (0.598 + .994\beta)\,CO$$

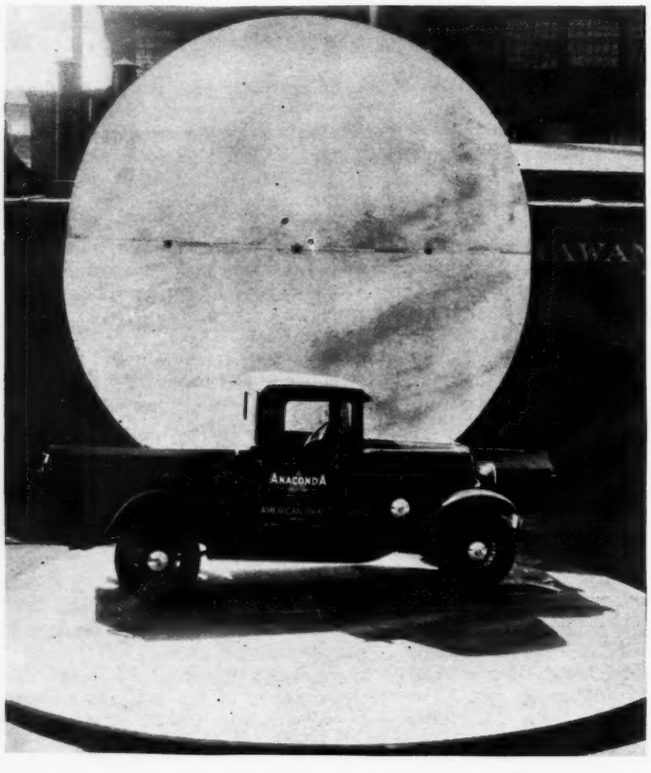
From the given analyses and formulas, Mr. Voinov computes the value of the gas characteristic β as 0.358 for the oil and 0.714 for the fuel gas.

He next assumes Orsat analyses as follows:

	CO_2	O_2
For fuel oil.....	12	4.2
For gas fuel.....	10	3.2

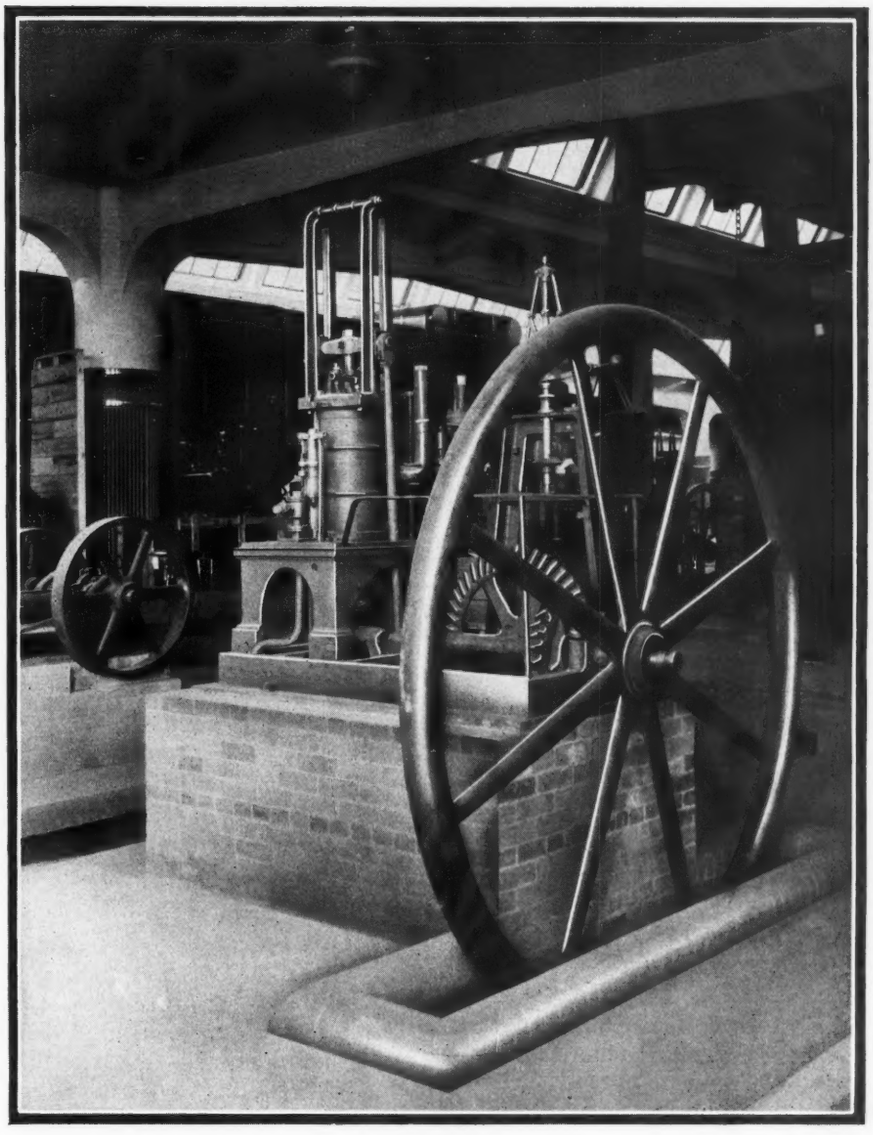
Now the question is whether the combustion was complete or not and what quantity of carbon monoxide was formed in the flue gases. Mr. Voinov answers this question by inserting the two flue-gas analyses in Formula 3, along with values of β. He finds that for the fuel oil the carbon monoxide should be zero, while for the flue gas it should be 0.5 He then compares these results with the gas analyses assumed by Mr. Dawson in the December, 1932, number of *Power*, showing that the assumed percentages of carbon monoxide are impossible.

"In applying their formula, the U.S.R.R. engineers make their conclusions rapidly and exactly, if only these formulas are correctly taken from the combustion handbook," Mr. Voinov concludes.



LARGEST SURFACE CONDENSER

Westinghouse Electric & Mfg. Co. is now engaged in building a surface condenser to contain 113,000 sq. ft. of tube surface within a single shell, a record for size. Muntz metal head plates for this condenser are the largest ever produced. Each plate is in two segments, each weighing 9,300 lb., 1¼ in. thick, 236 in. wide, with a radius of 126 in. When assembled on the condenser, head plates will be oval. Segments were fabricated in the Detroit mill of American Brass Co.



No. 6—BRAITHWAITE TABLE ENGINE

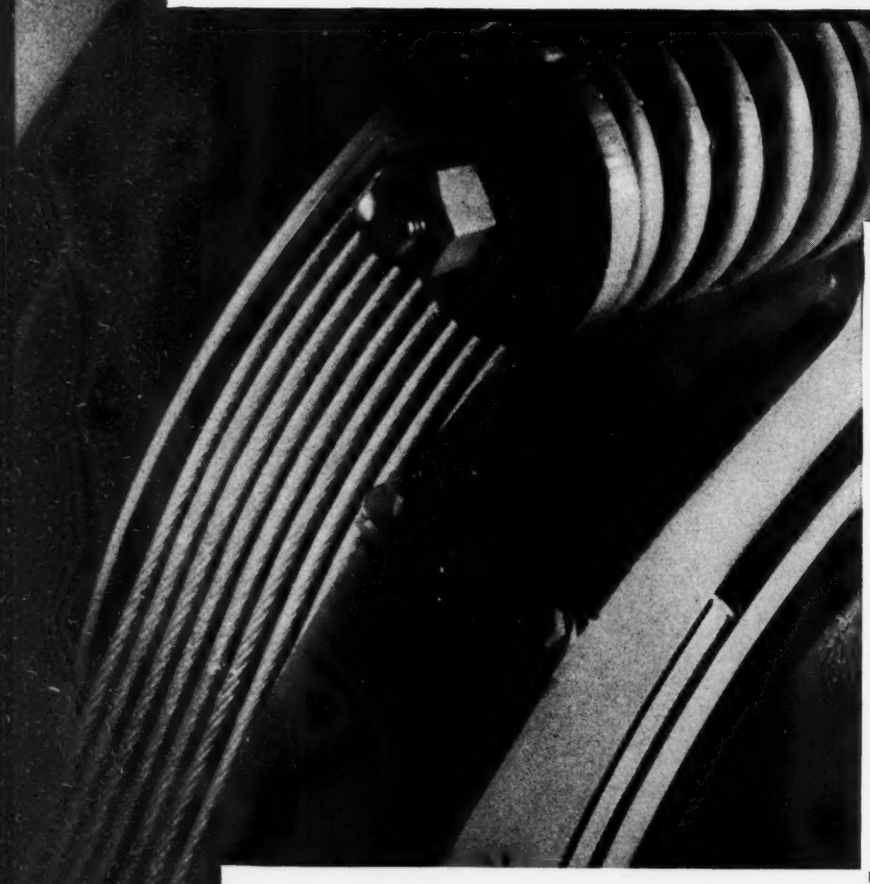
THIS is a table engine similar in design to that invented in 1807 by Henry Maudsley of London, England, and one of the many types of stationary engines which made their appearance in the first thirty years of the 19th century.

The engine pictured appears to have been made around 1850 and was used until 1928 at the Brewery near London, England, where it pumped ale into the cooling vats, in addition to providing power for the teagles, etc. It is now set up in the Edison Museum. It has a vertical cylinder of 8½-in. bore, which makes an upward stroke of 18 in., operating two connecting rods which work in vertical guides. The crankshaft is carried in bearings fixed below the same table upon which the cylinder rests. The valve is of the short-slide pattern and is operated by a single fixed eccentric which also works the pump. The engine is controlled by old type governors connected to a butterfly valve, and the flywheel is of oval section 8 ft. in diameter. The engine is non-condensing and works on a pressure of 50 lb. per sq. in.

It was made by Braithwaite, an engineer who practiced between 1795 and 1860 in New Street, Tottenham Court Road, London, England, and who in his day ranked amongst foremost steam engine makers in the world. It was he who in company with John Ericsson produced the "Novelty" locomotive which took a prominent part in the famous locomotive trials at Rainhill, England, in 1829. The first steam fire engines in the world were also made by Braithwaite.

STEAM PLANTS THAT MADE HISTORY

The Lubrication *of* Wire Rope



Practical Suggestions for the Correct Lubrication of Wire Rope . . . .

By the
TECHNICAL STAFF
STANDARD OIL COMPANY
(INDIANA)

THE efficient flow of production and the safe movement of materials and men throughout all industry, depend on the proper functioning of wire rope. And this, in turn, depends on proper care and lubrication.

Anyone who stops to consider the construction features of wire rope will appreciate the important part played by lubrication. Flexibility and good wearing qualities are diligently sought, and during the manufacture of the wire rope the hemp core and individual steel wire strands of the overlaying cables are thoroughly permeated with a lubricant.

This initial lubrication alleviates internal friction between the strands and aids in securing an *equal load distribution* on all strands. It has also been found that the hemp core itself lasts longer because of this lubrication. Thus made resistant to deterioration it continues to furnish proper strand support and gives longer life to the cable. The lubricant also protects the steel strands against corrosion by moisture and other liquids ordinarily encountered, and it aids materially in keeping out abrasive dust and dirt.

In this latter respect, a tough coating of lubricant is of particular service, for it helps to reduce the external friction with sheaves and guide pulleys.

The original lubrication of a wire rope is not sufficient to last throughout its life and ordinarily is not of the type that will give the best lubrication and protection in service. The best type of lubricant for service is seldom used at the time of manufacture for it dims the cable's clean, shiny appearance and interferes with an easy inspection of the cable strands by the purchaser. The proper care and lubrication of wire rope by the user under actual service conditions, therefore, becomes all the more important, and it is this phase of the subject with which we wish to deal.

Required Properties of Lubricant

A correct lubricant for wire ropes in actual service must:

1. Completely penetrate interior of cable.
2. Form a tough, tacky film on exterior of cable.
3. Resist washing action of water.
4. Resist drying out.
5. Prevent rusting or corrosion by ordinary liquids.
6. Exclude entry of moisture, abrasive dust, dirt.
7. Remain pliable indefinitely under all conditions; not cake or harden.
8. Not flake off, crack or peel in cold weather.
9. Not run off in hot weather.

Application

In order to secure thorough internal penetration from a product that will supply a tough, adhesive film on the exterior, *a hot application of the lubricant is preferred.* Upon cooling, the lubricant will assume the desired original heavy consistency.

Before the lubricant is applied, the cable must be thoroughly clean and free of moisture. Cables previously lubricated with ordinary oil or grease should first be cleaned with kerosene. When necessary to remove dust and dirt from the valleys or interstices of the cable strands, use a stiff brush or some other mechanical means to dislodge the material.

Apply the lubricant by bath if possible, preferably a hot bath, running the cable through a tank, box, or trough containing the lubricant and wiping the excess off or allowing it to drain back into the container. Application can also be made by brush or swab, or the lubricant can be dripped onto the cable as it is bent over a sheave, but such methods are inconvenient and tedious and on this account usually result in neglect of the cable by the men responsible for its care.

Other Maintenance Factors

Wire rope failures are often caused by other factors than faulty or neglected lubrication. Certain of these can be mentioned here appropriately and to advantage:

a. Improper unwinding of new cable from drum causing twisting of strands and kinking.
b. Undue flexing from adverse pulley lay-out and reverse bends.
c. Rough sheaves.
d. Sheaves of too small diameter.
e. Grooving too deep, causing pinching.
f. Misalignment of sheaves and drums.
g. Dragging cable over rough obstructions
h. Unnecessary dragging of cable through water, dust and dirt.

Lubrication Must Not Be Neglected

Because the correct lubrication of wire rope is not an easy task, it is too often neglected or not done properly. This situation is not aided when there is a feeling on the part of the user that a wire rope really requires no special attention or that the original lubrication supplied at the time of manufacture is sufficient. There is ample evidence to indicate, however, that unless the care and lubrication of a wire rope is right and, moreover, that it is never permitted to lapse, performance will suffer and the life of the cable will be seriously shortened.

A well lubricated wire rope will outlast many times a poorly lubricated one and will give more economical and better service throughout its life.

Copr. 1934, Standard Oil Co.

These practical discussions of specific lubrication problems, contributed by the technical staff, have been appearing for two years. A wide variety of subjects has been covered—a host of helpful, workable, suggestions made. These monographs are technical helps to the better solution of lubrication problems with which you are personally involved. They are yours for the asking. Please indicate the type of equipment in which you are most interested. Mention of your own position in your firm will also be appreciated.

CALUMET Compounds have been specifically developed to meet such problems as those involved in the lubrication of wire rope. Available in twelve different grades, Calumet Compounds No. 8 and No. 5 have proven the most popular. Number 8 is especially recommended for summer temperature conditions.

Standard Oil Lubrication Engineers will be glad to assist in the application problems involved in correct lubrication of your own wire rope. Call them in. Standard's Lubrication Engineering Service is available at any time for advice on specific lubrication problems, or for a complete lubrication survey of your operations. The savings which result from these Standard Oil surveys are, as a rule, extremely worthwhile.

-»CORRECT LUBRICATION«-

OIL COMPANY (INDIANA)

Number 21

Evaporation Costs

COAL

Pounds Steam per lb. coal	Evaporation											
	5	5½	6	6½	7	7½	8	8½	9	9½	10	
Coal Cost Dollars ton	Cost per 1,000 lb. of water evaporated, cents											
3.50	35.0	31.8	29.2	26.9	25.0	23.4	21.9	20.6	19.4	18.4	17.5	
3.75	37.5	34.1	31.2	28.8	26.8	25.0	23.5	22.1	20.8	19.7	18.7	
4.00	40.0	36.4	33.4	30.6	28.6	26.7	25.0	23.5	22.2	21.0	20.0	
4.25	42.5	38.6	35.4	32.6	30.3	28.3	26.5	25.0	23.6	22.3	21.2	
4.50	45.0	40.8	37.5	34.6	32.1	30.0	28.1	26.4	25.0	23.6	22.5	$0.02½ Gal
4.75	47.5	43.2	39.6	36.6	33.9	31.7	29.7	27.9	26.4	25.0	23.7	
5.00	50.0	45.5	41.7	38.5	35.8	33.4	31.2	29.4	27.8	26.3	25.0	
5.25	52.5	47.7	43.7	40.5	37.6	35.0	32.8	30.9	29.2	27.7	26.2	0.03
5.50	55.0	50.0	45.8	42.3	39.4	36.6	34.4	32.3	30.5	28.9	27.5	
5.75	57.5	52.2	47.8	44.3	41.0	38.3	36.0	33.8	31.9	30.2	28.7	
6.00	60.0	54.5	50.0	46.1	42.7	40.0	37.5	35.3	33.3	31.5	30.0	0.03½
6.25	62.5	56.7	52.1	48.0	44.5	41.6	39.1	36.8	34.7	32.8	31.2	
6.50	65.0	59.1	54.2	50.0	46.4	43.2	40.6	38.2	36.1	34.2	32.5	
6.75	67.5	61.5	56.2	51.8	48.2	45.0	42.2	39.6	37.5	35.4	33.7	
7.00	70.0	63.6	58.4	53.8	50.0	46.7	43.8	41.1	38.9	36.7	35.0	0.04
7.25	72.5	65.0	60.5	55.8	51.8	48.3	45.3	42.6	40.3	38.1	36.2	
7.50	75.0	68.2	62.5	57.7	53.6	50.0	46.8	44.1	41.7	39.4	37.5	
7.75	77.5	70.5	64.5	59.6	55.4	51.6	48.4	45.6	43.1	40.7	38.7	
8.00	80.0	72.7	66.6	61.5	57.2	53.3	50.0	47.0	44.5	42.0	40.0	0.04½
8.25	82.5	75.0	68.8	63.5	59.0	55.0	51.6	48.5	45.8	43.4	41.2	
8.50	85.0	77.3	71.0	65.4	60.7	56.7	53.2	50.0	47.2	44.7	42.5	
8.75	87.5	79.5	73.0	67.3	62.5	58.4	54.7	51.5	48.6	46.2	43.7	
9.00	90.0	81.7	75.0	69.1	64.2	60.0	56.2	52.9	50.0	47.2	45.0	0.05

Cost of ash disposal and handling should be added to the above costs

GAS

Gas cost per Therm 100,000 B.t.u. (in cents)	Gas cost per 1,000 cu.ft. 800 B.t.u. per cu.ft.	Efficiency — Per cent						
		70	75	80	85	90	95	
		Pounds of Steam per Therm						
		72.2	77.4	82.5	87.5	92.5	97.5	
		Cost per 1,000 lb. of water evaporated, cents						
1½	$.12	20.8	19.4	18.2	17.2	16.2	15.4	
1⅝	.13	22.5	21.0	19.7	18.6	17.6	16.7	
1¾	.14	24.2	22.6	21.2	20.0	19.0	18.0	
1⅞	.15	25.9	24.3	22.7	21.5	20.4	19.3	
2	.16	27.7	25.9	24.3	22.9	21.7	20.5	
2⅛	.17	29.5	27.5	25.8	24.3	23.1	21.9	
2¼	18	31.2	29.1	27.3	25.7	24.3	23.2	$.02½ Gal.
2⅜	.19	32.9	30.7	28.8	27.1	25.7	24.5	
2½	.20	34.6	32.3	30.3	28.6	27.0	25.7	
2⅝	.21	36.3	33.9	31.8	30.0	28.4	26.9	0.03
2¾	.22	38.0	35.5	33.3	31.4	29.7	28.2	
2⅞	.23	39.9	37.1	34.8	32.9	31.1	29.5	
3	24	41.4	38.7	36.3	34.3	32.4	30.8	
3⅛	.25	43.3	40.3	37.8	35.7	33.9	32.1	0.03½
3¼	.26	44.8	41.9	39.3	37.1	35.2	33.4	
3⅜	.27	46.6	43.5	40.8	38.5	36.5	34.7	
3½	.28	48.4	45.2	42.4	39.9	37.8	36.0	0.04
3⅝	.29	50.2	46.7	43.8	41.3	39.2	37.3	
3¾	30	51.9	48.3	45.3	42.7	40.5	38.6	
3⅞	31	53.6	49.9	46.8	44.1	41.8	39.7	
4	32	55.4	51.5	48.5	45.7	43.2	41.0	0.04½
4⅛	33	57.1	53.1	50.0	46.2	44.5	42.3	
4¼	34	58.8	54.7	51.5	48.6	45.8	43.7	
4⅜	35	60.6	56.3	52.8	50.0	47.3	45.0	
4½	36	62.5	58.2	54.5	51.3	48.5	46.3	0.05

FUEL OIL

Lbs. Steam per lb. Oil	Evaporation									
	11	11½	12	12½	13	13½	14	14½	15	15½
Lb. Steam per Gal. Oil	88	92	96	100	104	108	112	116	120	124
Cost of Oil Cents per Gal.	Cost per 1,000 lbs. of water evaporated, cents									
2¼	25.7	24.5	23.3	22.5	21.7	20.9	20.1	19.4	18.7	18.1
2⅜	27.1	25.8	24.7	23.7	22.9	22.0	21.2	20.5	19.7	19.1
2½	28.5	27.2	26.0	25.0	24.1	23.2	22.3	21.6	20.8	20.1
2⅝	29.9	28.6	27.3	26.3	25.3	24.4	23.4	22.6	21.9	21.2
2¾	31.3	30.0	28.6	27.5	26.5	25.6	24.5	23.7	22.9	22.2
2⅞	32.7	31.4	29.7	28.7	27.7	26.7	25.7	24.8	24.0	23.2
3	34.1	32.7	31.2	30.0	28.9	27.8	26.8	25.9	25.0	24.2
3⅛	35.5	34.1	32.6	31.3	30.1	29.0	27.9	27.0	26.1	25.2
3¼	36.9	35.5	33.9	32.5	31.3	30.1	29.0	28.1	27.1	26.2
3⅜	37.5	36.9	35.2	33.8	32.5	31.3	30.1	29.2	28.2	27.2
3½	39.8	38.2	36.5	35.0	33.7	32.4	31.2	30.2	29.2	28.2
3⅝	41.2	39.6	37.9	36.2	34.9	33.6	32.4	31.3	30.2	29.3
3¾	42.6	40.9	39.2	37.5	36.1	34.8	33.5	32.4	31.3	30.3
3⅞	44.0	42.2	40.5	38.7	37.3	35.9	34.6	33.5	32.3	31.3
4	45.5	43.6	41.8	40.0	38.5	37.0	35.8	34.6	33.3	32.3
4⅛	47.0	45.0	43.1	41.3	39.7	38.1	37.0	35.7	34.3	33.3
4¼	48.4	46.4	44.4	42.5	40.9	39.2	38.1	36.8	35.3	34.3
4⅜	49.8	47.8	45.7	43.8	42.1	40.4	39.2	37.9	36.3	35.3
4½	51.2	49.2	47.1	45.0	43.3	41.5	40.4	38.9	37.5	36.3
4⅝	52.7	50.4	48.4	46.2	44.5	42.7	41.5	39.9	38.5	37.3
4¾	54.1	51.8	49.7	47.5	45.7	43.8	42.6	41.0	39.5	38.3
4⅞	55.5	53.2	51.0	48.7	46.9	45.0	43.7	42.1	40.6	39.3
5	56.9	54.7	52.3	50.0	48.1	46.1	44.8	43.2	41.6	40.4
5⅛	58.4	56.1	53.6	51.3	49.3	47.3	46.0	44.2	42.6	41.4
5¼	59.8	57.4	54.9	52.5	50.5	48.4	47.1	45.3	43.6	42.4
5⅜	61.2	58.8	56.2	53.8	51.7	49.6	48.2	46.4	44.7	43.4
5½	62.7	60.1	57.5	55.0	52.9	50.7	49.3	47.5	45.8	44.4

FIGURES in these tables are simply computations. Select the evaporation rate of your plant, and use that figure and the cost of your fuel per ton to find the cost of fuel per 1,000 lb. of steam evaporated. In the table for coal, cost of ash disposal and handling should be added to the costs shown.

In the coal and gas tables, diagonal lines indicate where the cost of coal, or the cost of gas, at the price shown in the left-hand column and the cost of fuel oil at the price labeled on the line, will be equal—based on an evaporation rate of 14 lb. per pound of oil, which should be obtained with proper equipment. If your evaporation cost figure is below the price line at which you can buy fuel oil, you are paying more for the coal or gas than you would for fuel oil. If your evaporation cost figure is above the price line, the coal—or the gas—is cheaper.

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HOW TO FIND ULTIMATE from PROXIMATE ANALYSIS

By NORMAN L. KORN

MANY a practical combustion problem cannot be solved unless you know the ultimate analysis of the coal. Yet almost never can the plant afford an ultimate analysis; the average engineer thinks himself lucky if he gets a periodic proximate analysis.

What to do? The practical answer is that the ultimate analysis can be closely determined from the proximate. It's easy, with the help of the chart here shown.

The basis of the whole business, of course, is the finding of the total carbon in the coal. The proximate analysis gives fixed carbon only; what additional carbon is in the volatile?

If you know the volatile, the chart gives you the "conversion factor" for getting the fixed carbon. I have no idea why the two are related as shown, but "the proof of the pudding is in the eating." So try it! After you get the total carbon, calculate the other elements by the method suggested by the late Professor Parr.

Directions: First reduce the volatile to the ash-and-moisture-free basis, dividing each percentage by 100 — (ash + moisture). Enter the chart with this and read the conversion factor. Add this to the fixed carbon (also ash-and-moisture-free) and the sum is the total carbon.

Calculate the remainder of the proximate analysis to an ash-and-moisture-free basis and proceed thus:

1. 4,050 × weight of sulphur = B.t.u. of sulphur.
2. 14,544 × weight of carbon = B.t.u. of carbon.
3. Consider nitrogen a constant of about 1.4 per cent.
4. Total B.t.u. — (No. 1 + No. 2) = B.t.u. of free hydrogen.
5. $\frac{\text{B.t.u. of hydrogen}}{62{,}500}$ = weight of free hydrogen.
6. 100 — (C + S + H + N) = (O + H) combined.
7. 8/9 (O + H) = weight of oxygen.
8. 1/9 (O + H) = weight of combined hydrogen.
9. Free hydrogen + combined hydrogen = total hydrogen.

(O + H) is the weight of oxygen in the coal plus the weight of hydrogen needed to form water.

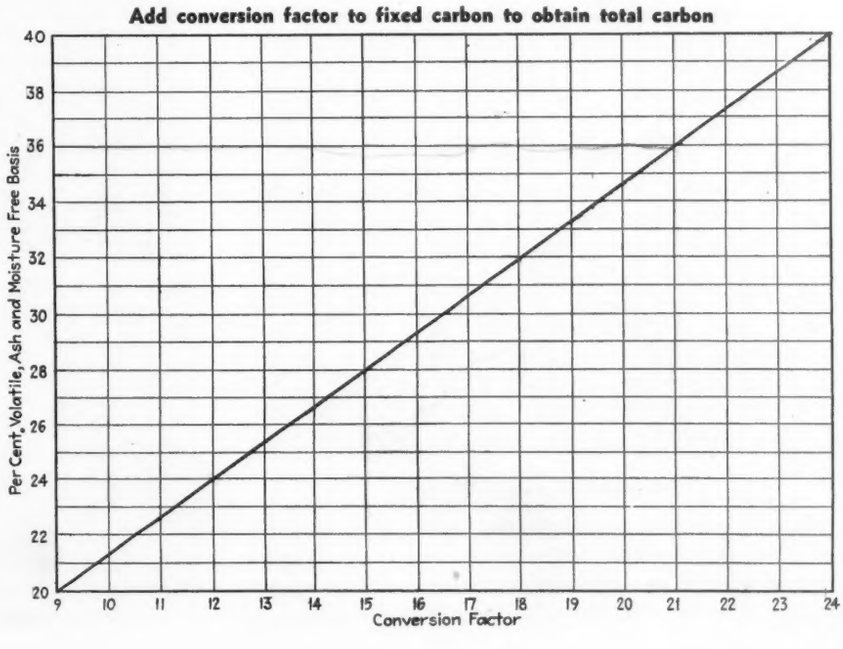
The work of Parr has been altered slightly to fit into the general procedure, but it is fundamentally the same as he proposed it. He believed the nitrogen could be considered to average 1.25 per cent but I feel that for a wide range of coals this average will be about 1.40 per cent. Parr used 5,000 as the B.t.u. developed by combustion of sulphur, although the accepted value is 4,050. In conclusion, I wish to point out that:

1. The accuracy of the method is dependent on the value of the carbon as found by the graph.
2. The calculation is extremely simple.
3. The difficulty of getting a representative sample of coal for the chemist to analyze is so great that any error introduced by these calculations is not fatal to the continued use of the method.
4. The graph is empirical, based on analyses of coals from the Appalachian or Eastern Province.
5. Although the error is small for Pennsylvania coals, less than 1 per cent, the chart shows a decided tendency to give too low a value for West Virginia coals, but seldom more than 2 per cent.

Comparison of Ultimate Analyses With Ultimate Computed by This Method

	Proximate Analysis — As Received					Ultimate Analysis Ash and Moisture Free			
Coal	Fixed Carbon	Volatile	Sulphur	Ash and Moisture	Heating Value	O	C	H	N
Illinois....	50.44	30.68	0.49	18.88	11,725	10.14	82.19	5.30	1.76
Calculated						9.24	84.10	4.67	1.40
Difference.						0.90	1.91	.63	0.36
Kentucky.	57.53	36.33	0.55	6.14	14,170	6.94	85.09	5.68	1.70
Calculated						8.20	84.30	5.50	1.40
Difference.						1.26	.79	.18	0.30
Ohio.....	51.95	34.22	1.98	13.83	12,721	7.87	82.83	5.47	1.57
Calculated						8.05	83.10	5.14	1.40
Difference.						0.18	0.27	.33	0.17
Penn.....	64.40	25.21	2.19	10.39	14,000	3.02	87.86	5.16	1.52
Calculated						4.18	86.80	5.18	1.40
Difference.						1.16	1.06	0.02	0.12
W. Va....	58.78	32.29	0.63	9.00	13,981	5.80	85.50	5.38	1.61
Calculated						7.19	85.10	5.63	1.40
Difference.						1.39	0.40	0.25	0.21

Add conversion factor to fixed carbon to obtain total carbon



WHAT TYPE FAN

FOR FORCED AND INDUCED DRAFT

By A. A. CRIQUI
Chief Engineer, Buffalo Forge Co.

If you have fuel-burning equipment, that's a proper question. Here performance characteristics of straight, forward-curved, and double-curved blades are discussed with reference to their suitability for use as induced- or forced-draft fans

FORCED-DRAFT fans in use include the old low-speed radial blade, the forward-curve blade and the newer backward-curved blade types. For induced draft, the two former types and a modified type of the backward-curved blade are used.

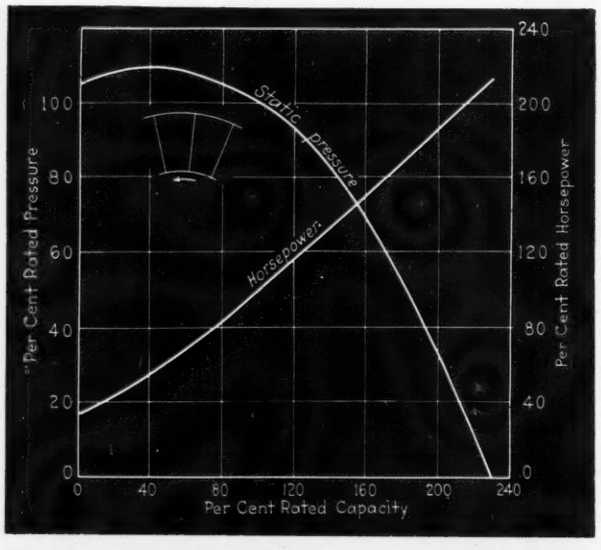
The old radial blade is seldom used now, except where pressure requirements are relatively low and direct connection to a steam engine is required. This type of fan is well suited to forced- or induced-draft service, having a pressure characteristic which rises gradually from free delivery to approximately no delivery, making it suitable for parallel operation over wide ranges of capacity. The flexibility of engine drive permits economical adjustment of speed to air and pressure requirements. While, under certain conditions, a high efficiency is possible with a long radial-blade fan, the requirements of mechanical draft do not always permit of the more efficient proportions of design. On account of its low speed, the housing becomes prohibitively large for high pressures and it is not well suited to direct drive by electric motor or turbine.

Straight-Blade Fan

Fig. 1 shows the pressure and horsepower characteristics of the straight-blade fan. It is usually rated at or immediately beyond the high point of efficiency. If the static resistance increases for any reason, the capacity drops back slightly to the left and the pressure rises to meet the greater demand. This characteristic prevents the boiler from dropping off very far in rating. The horsepower characteristic is not so favorable, since it increases continuously as resistance is reduced, so that a reasonable margin of power must be supplied.

Forward-Curved Blade

The forward-curved blade fan, while quite suitable for this class of work under some conditions, must be selected with discretion in regard to its point of operation, as it is very sensitive to variations in resistance.



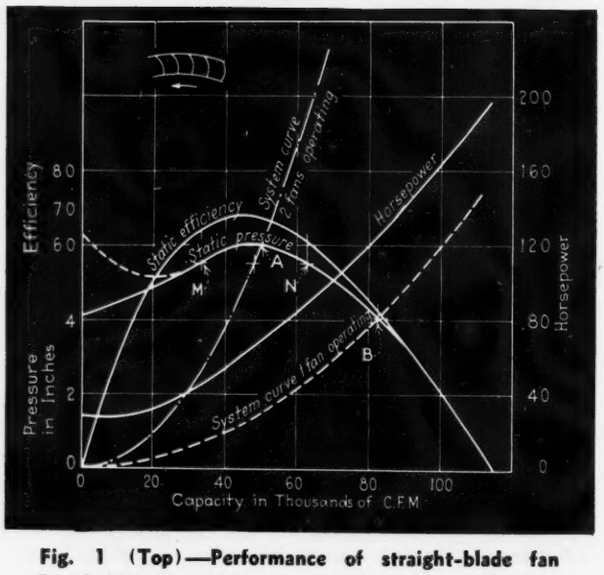


Fig. 1 (Top)—Performance of straight-blade fan
Fig. 2 (Above)—Performance of forward-curved blades

It makes a satisfactory unit as a single-inlet fan where the speed is variable. The pressure characteristic is not the most desirable, and parallel units are recommended in exceptional cases only, namely, where conditions are rigidly fixed, thereby preventing one unit from "hogging" the load.

Referring to Fig. 2, it will be noticed that a decided dip occurs in the fan-pressure curve. This dip is characteristic of the forward-curved blade fan, and is due to the development of a large portion of the static pres-

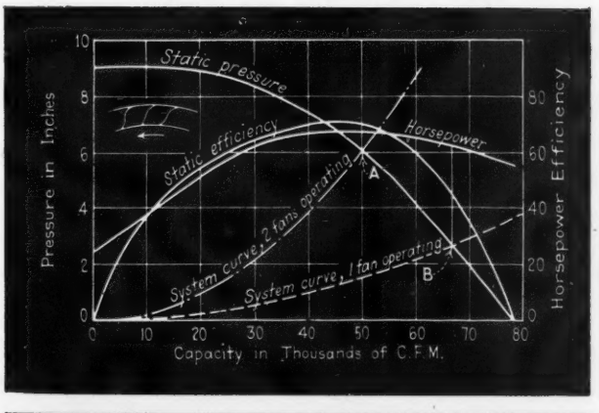
sure by converting the unusually high velocity of the air leaving the tip of the blade into static pressure in the diverging scroll of the fan housing. When this fan operates well to the right of the peak of the static-pressure curve, satisfactory performance may be obtained. Where several fans are operating in parallel, or in the case of one double-inlet, double-width fan, one fan is likely to "hog" the load while the other drops back to a much lower capacity but at the same pressure as its parallel fan, both operating at much lower efficiency. This unequal division of the capacity load and wavering of the pressure is sometimes called "hunting," and may be caused by slightly less resistance on one fan.

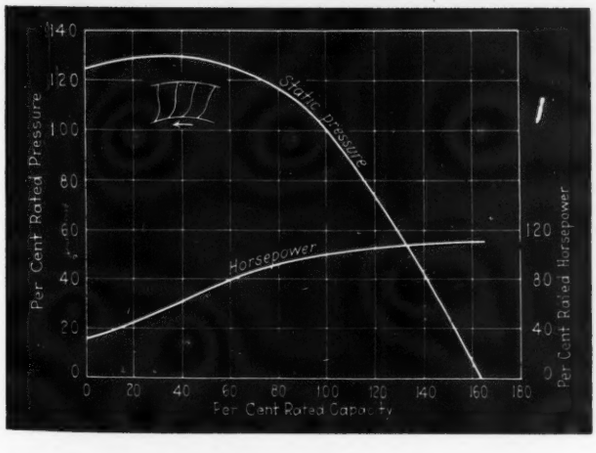
The horsepower characteristic on the forward-curved fan rises more rapidly than that of the radial-blade fan; therefore, a suitable margin of power must be provided in the driving motors. If the exact air and pressure requirements could be foretold with accuracy it would not be necessary to provide any appreciable margin on account of this rising horsepower characteristic. Although accurate estimates are made of the fan requirements, the mere changing of the grade of coal used or some necessary alterations that might occur in installation may result in a considerable increase in horsepower. In parallel units especially, the power is likely to be quite different than that calculated.

Take, for example, a case in which each of two forced-draft fans discharging into one system is required to handle 50,000 c.f.m. at 6-in. static pressure and rated at point *A* on Fig. 2, or a total of 100,000 c.f.m. at 6-in. static for the system. Assume that the resistance on each inlet is the same, but that one fan is started before the other. It will come to a balance with the resistance characteristic of the system at point *B*, requiring 125 hp., while the horsepower at rating point *A* is 69.75.

When the second fan is started, it will increase in capacity as the first one decreases until they come to a combined capacity and pressure that falls on the system characteristic curve for two fans operating. In the above case these points will be at *M* and *N*. Both fans deliver a combined capacity of 96,000 c.f.m. at 5.52 static pressure and at a static efficiency of 64 and 61 per cent instead of their rated static efficiency of 67.5. Where pressure requirements are quite high, the forward-curved fan is not practicable, since the reasonably stable rating points of operation occur at too high velocities through wheel and housing, and ratings at suitable velocities are in the dip or unstable part of the pressure curve.

Fig. 3 (Top)—Performance of double-curved blades with backward tip. Fig. 4 (Below)—Performance of modified double-curved blades for induced draft





Backward-Tip Blade

The backward-tip blade has the blade in continuous backward curvature or, with the double-curved blade type, has a forward angle at the heel of the blade and a backward angle at the tip. This double-curved blade presents a shape inherently strong and well suited for high tip speeds without intermediate reinforcing of the blade, as is required in the former. This latter type is equipped with stationary inlet guide vanes. These vanes both cut down the fan inlet losses by turning the air in direction of wheel rotation and produce more uniform flow along the tip of the wheel by distributing the air across the blade.

Fig. 3 shows the characteristics of this type. The pressure rises continually from free delivery to shut-off, eliminating the possibility of any great difference in the capacity of two fans operating in parallel, but with unbalanced resistance. The maximum horsepower occurs near the usual rating point, which is at or slightly to the right of maximum efficiency. Little margin in motor power for the greatest possible change in air requirements need be provided. The fan is the higher-speed type which renders it most suitable for direct motor or turbine drive.

Apply the case previously given for two fans of this latter type by referring to Fig. 3. Each fan is rated at point *A* to handle 50,000 c.f.m. at 6-in. static pressure. If one is started first, it will meet system resistance curve at *B'* requiring 62.0 hp., while at rating point *A'* the hp. is 67.2, imposing no overload on the motor. When the second fan is started, it will gradually increase in capacity as the first fan decreases until their combined capacity and pressure meets the system resistance curve for two fans operating. The first point where a balance can occur will be at the rating point *A'*, which is the desired operating point.

Modified Blade

For low-pressure induced-draft work this backward-curved type is quite practicable. For the higher pressure ranges this fan is designed with blade-tip angle nearly radial but with forward angle at the heel. This produces the higher pressures within the motor and turbine speed ranges, making direct connection possible.

Fig. 4 shows the characteristics of this fan, it has the desired rising pressure characteristic throughout the entire working range, making it suitable for parallel operation and safe from power overload.

INDICATOR REVEALS CONDITION OF GAS-

Gas engines often are operated under uneconomical conditions, largely because operators have little or no knowledge of methods of checking performance. Proper interpretation of indicator cards is one answer

MOST gas engines are governed by the mixture quantity method. The gas pressure is reduced at a point near the engine to that of the atmosphere by a sensitive regulator, Fig. 1, so that both gas and air enter the mixing valve, if conditions permit, at atmospheric pressure.

The governor-controlled air throttle *a*, Fig. 2, and the governor-controlled gas throttle *b* close snugly against machined seats, and as they open they create air and gas orifices increasing in size but always in the same proportion. Thus if their relative areas are ten to one at the friction-load position they will remain ten to one at the full-load position.

To compensate for gas quality and other variables, the ratio between air and gas openings, and the consequent mixture ratio, require manual adjustment. This is accomplished by ingenious devices. In Fig. 2 the governor operates directly on butterfly *a* through arm *c* and link *d*. The gas throttle *b* is actuated from an extension on arm *c* through link *e* and arm *f*. The extension of arm *c* is made curved, and the head of link *e* is made slidable along the arc, thus varying the amount of movement given arm *f* by arm *c*. This arc is struck from the center *g* when both valves are closed. By this means both valves close at the same time and preserve any desired ratio while opening.

Other engines use sleeve valves which accomplish the same result by rotating the inner sleeve to shorten the circumferential width of the gas port while widening the air port or the contrary, the governing being effected by axial movement of the inner sleeve.

With good workmanship and correct adjustment, diagrams much like Figs. 3, 4, 5 and 6 result. The increasing vacuum (lower line, Fig. 3) accompanied by a compression line crossing the atmospheric line late in the stroke, and low compression are most notable in the friction load card, Fig. 3.

It is observed, too, that the rate of burning in Fig. 3 is reduced as the load is decreased, the ignition timing remaining unaltered. There are two causes for this. The rate of flame propagation decreases with lowered compression, a matter beyond the operator's control. The other cause is unfavorable air-intake piping.

Back-firing is caused by a slow-burning mixture, usually by one that is too lean.

An operator was adjusting the gas-air mixture when

Fig. 1 — Sensitive regulator for reducing gas pressure near the engine

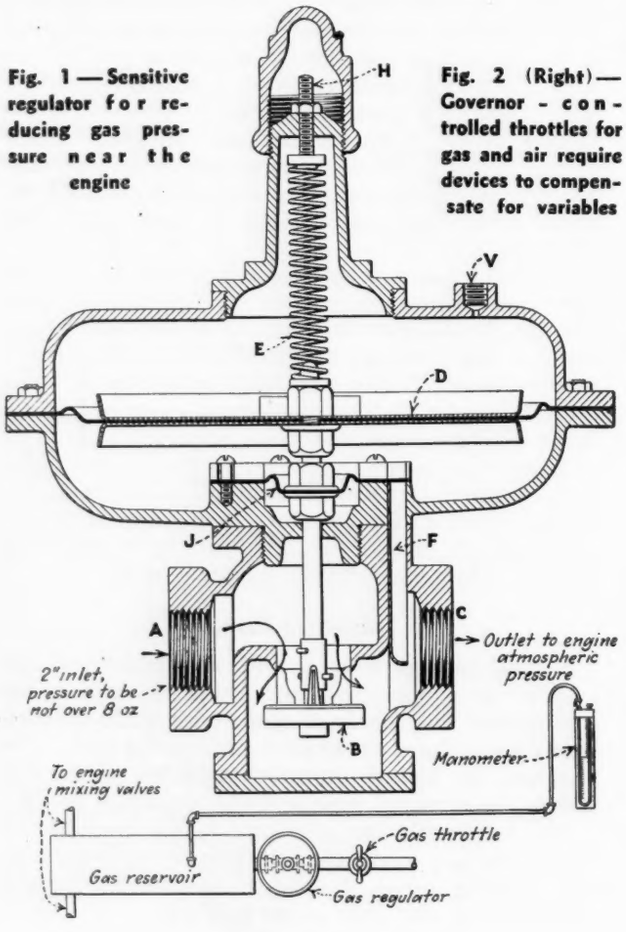
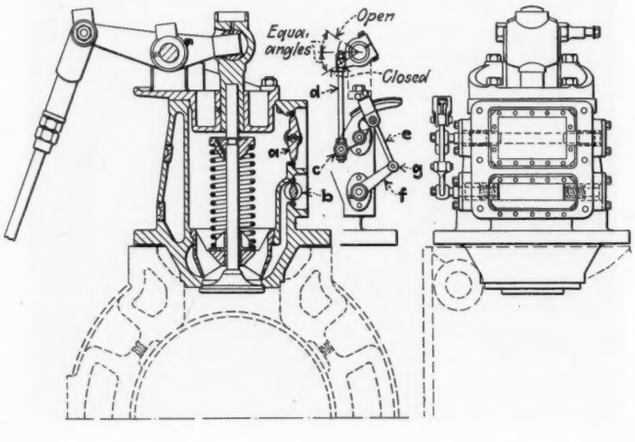


Fig. 2 (Right) — Governor-controlled throttles for gas and air require devices to compensate for variables



MIXING VALVE

By H. F. SHEPHERD

the card in Fig. 7 was taken. The indicator was in communication with the combustion chamber. It was fitted with the ½-sq.in. area piston and a 12-lb. spring and stop to limit the height of the pencil movement. Thus suction and exhaust lines are exaggerated to a scale of 12 lb. per in.

The mixture was thinned, reducing its rate of combustion so much that it was burning after the exhaust valve opened, holding the pressure up even on the exhaust stroke from *a* to *b*. Flickering still when the inlet valve opened, the burning cylinder contents fired the incoming fuel charge, the rise of pressure *d* causing violent back flow through the inlet valve with the characteristic noise of back-fire. This was repeated at *c–f*.

A mixture less removed from the good operating ratio produces irregular light-load diagrams like Fig. 8, burning continuing through a large part of the stroke. Cards like this are made when the mixing valve is badly misadjusted or damaged by filing.

Sleeve throttling valves, even those of the butterfly type, stick when coated with gummy deposits of oil and dust, a trouble much reduced by the use of proper air filters. To lengthen the intervals between cleaning, the operator may file the valve. The resulting leakage destroys the original intention, producing a bad mixture at light loads. The port opening at friction load is but a few thousandths of an inch, and the vacuum in manifold or cylinder may be from 6 to 8 lb. Leakage is a serious matter under such conditions.

Both the back-fire, Fig. 7, and the irregularly delayed combustion, Fig. 8, are produced at light load under more mysterious conditions with an engine that appears to operate normally at full load. A long air intake pipe often is a necessity. Aspiration noises are a nuisance in a building, intake pulsations may rattle windows, and the great volume of air withdrawn from the room may make heating impossible.

When a long intake pipe is used, the air enters the throttle at atmospheric pressure, less the drop due to pipe friction. Unfortunately this drop is not constant, but increases with the load. If the mixture is set for good operation at full load, it becomes too lean at lighter loads and reduced air pipe resistance.

A clever Californian met this condition by connecting the diaphragm vent *v* of the regulator, Fig. 1, to the intake pipe at a point close to the mixing valve, thus placing the gas pressure under control of the air pressure prevailing at the engine rather than the atmospheric pressure.

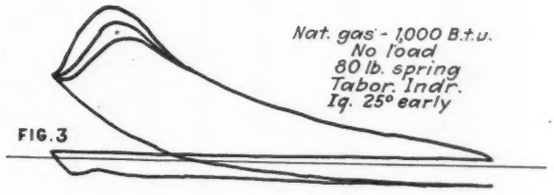


FIG. 3

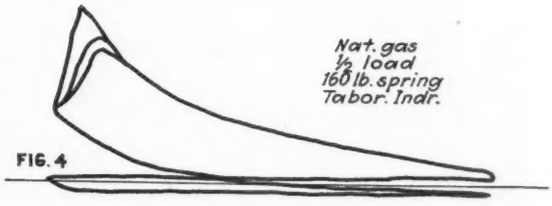


FIG. 4

FIG. 5

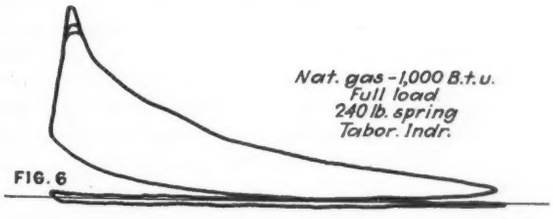


FIG. 6

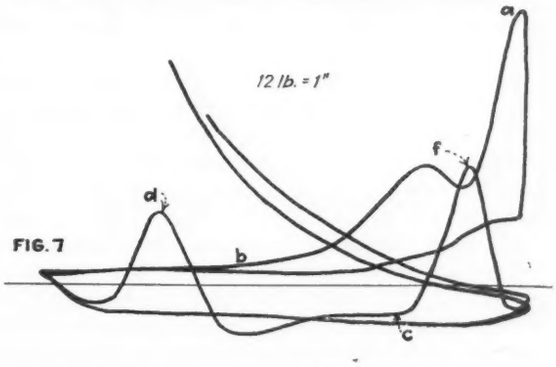


FIG. 7

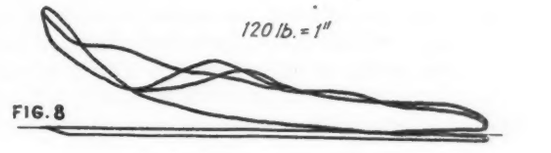
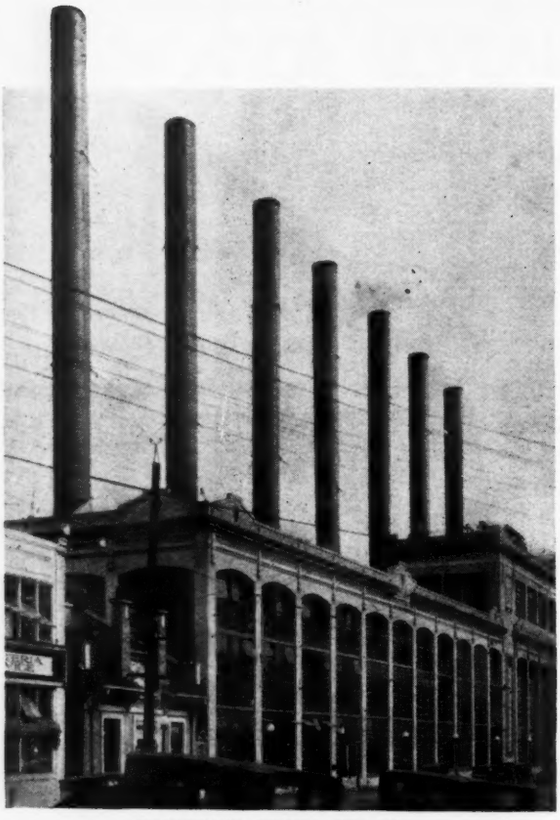


FIG. 8

PAINTING

WHAT YOU SHOULD KNOW ABOUT IT—2

By E. J. TANGERMAN
Assistant Editor



SEATTLE'S SEVEN STACKS

Lake Union Steam Plant, Seattle, Wash., confronted with many varieties of stack paints, decided to test them over a 4-yr. period by painting different stacks with different types. Bituminous-type paints proved best.

THE best way to discuss surface painting is probably to divide surfaces by type into masonry or wood, steel, and boilers or other heated surfaces.

Masonry and Wood

These are usually large flat surfaces. A light-colored pigment should be used, such as lithopone, zinc oxide, white lead, Titanox (titanium oxide) and aluminum. White lead, a good exterior wood protective coating, is almost useless inside a power plant, because it discolors from sulphur or fumes, thus losing its light-reflecting ability. Titanox is a chalking type pigment, often used with lithopone or zinc oxide, or both in "mill whites," which do not discolor. Usually, combinations of lithopone and zinc oxide or burnished aluminum flake are best for wall coatings.

In white paint, particularly a mill white, tests have shown that paints composed of a combination of two or more white opaque pigments, with small amounts of tinting colors, have much longer life and keep their original appearance much longer than a one-pigment paint or any combination of white pigments untinted. Tests show that a color slightly off white and toward an ivory is most restful to the eye and sacrifices almost no light. The ivory is obtained by adding small amounts of chrome or sienna pigments to a mill white, and the combination resists yellowing markedly.

The vehicle, or oil content, used with these pigments is also very important. Linseed oil (raw or boiled), linseed and rosin combinations, DeMar gum, kauri gum, congo gum, China wood oil and synthetic resins are commonly available. Usually, in cold damp places, hot dry places, hot humid places, or under normal conditions, boiled linseed oil does the best job. It may discolor in hot humid places, however. DeMar gum with linseed oil withstands high humidity and acid fumes, but will not stand up under temperatures above 85 deg. F.

One other element should be considered in choosing a mill white—the comparative advantages of egg shell and high-gloss paints. Egg-shell paint is usually better. It diffuses light without glare, may be washed or scrubbed readily, does not chip or flake off, is unaffected by moisture or vibration. High-gloss paints cause glare, collect more dirt than egg shell, are harder to keep clean and in good condition, have pigment content less than that in egg shell, do not reflect as much light, and have greater tendency to yellow.

This all leads to the general conclusion that a first-class interior masonry or wood wall paint is an egg-shell type, with a linseed oil vehicle and a combination of lithopone and zinc oxide pigmentation tinted to an ivory. This is, of course, specifically for finish coats. Masonry walls previously unpainted should be sealed with a spar varnish followed by an undercoater or flat. If a sealer is not used, the wall will "suck" the subsequent coat, causing flat spots in the finish film. Lime compounds in the mortar, if not covered, may also "lime burn" the oils in finish coats. Lime burn can be avoided by neutralizing with a wash of 3½ lb. of zinc sulphate per gallon of water. The flat undercoat is the "hiding coat," which when covered by the finish coat makes the film opaque.

Priming or undercoats on wood should form a proper bond between wood and primer, should be hard enough to support finish coats, and should provide a good surface for finish coats. White lead and oil is usually the best undercoat. A suitable volatile solvent, such as turpentine, gives necessary bonding with the wood. Mill white flats also give excellent results as first coats on interior woodwork, providing a saving where exposure is not too severe. Knots and pitch streaks should be sealed over first with shellac or with aluminum powder in varnish (which also may be used as a priming coat for mill white). Finally, undercoats should not be applied shortly after a rain, during very humid weather, or during cold or frosty weather.

Oil spots on masonry or wood should be removed with benzine or similar fluid, followed by sealing with aluminum paint prior to painting with mill white. A masonry wall with free alkali present (detectable by application of a little phenolthalein) should first be

treated with a solution of 3 lb. zinc sulphate to a gallon of warm water. After this dries, the salt it forms should be dusted from the wall before sealing.

Aluminum flake (this should pass 100 per cent through a 140-mesh screen and should be 99 per cent pure aluminum to avoid mica adulteration), mixed 2 lb. of flake to the gallon of china wood oil spar varnish (forming 1⅛ gal. of paint), is an alternative coating to replace mill white. This is particularly good in boiler rooms, because it sheds dust readily, is inexpensive and offers light reflection second only to that of mill white. Aluminum powder, unlike other pigments, does not have to be ground in oil. The pigment is simply stirred into the vehicle to form a suspension. It should be applied the same day, however, to get maximum leafing, brightness and hiding power.

Steel Surfaces

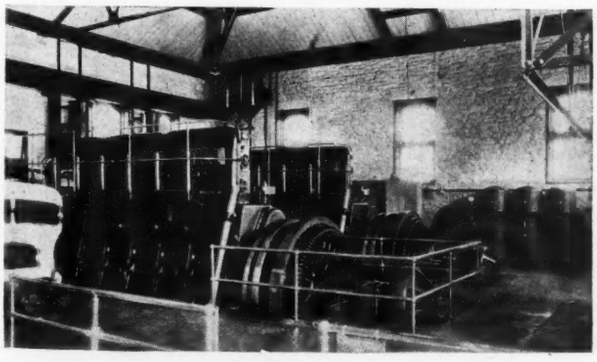
Steel rusts, but recent tests have shown that an electrolite must be present—for rusting is not pure oxidation, but an electrolytic process. Thus any paint which is a good conductor of electricity is not desirable for painting steel. Rust inhibition (or prevention) of pigments rates thus, considering 10 as maximum protection and 0 as minimum:

Artificial graphite	0
Lamp black	0
Sublimed white lead	3.5
Red lead	4
Natural silica-flake graphite	4
Sublimed blue lead	6
American vermilion or lead chromate	7.5

Lead chromate can be mixed with spar varnish vehicles, while red and blue leads must be mixed with raw linseed oil to give best results. Thus, the advantage of the former is twofold: A spar varnish can be flattened to permit excellent bonding between priming and finish coats, while linseed oil gives a glossy surface difficult to apply succeeding coats to. The spar varnish is much faster drying also. These make it much better for priming coats on steel. A red lead and natural graphite mixture in boiled linseed oil is commonly used with satisfaction.

The primer is not good for a finish coat, however. It should be coated before extensive corrosion or abrasion with a good protective coating. For a light-colored finish, aluminum in spar varnish is excellent.

If black or dark green finish coats are desired on steel, graphite paints give excellent protection. Natural silica-flake graphite is preferable because it "leafs" over a surface to form a shingle-like structure highly impervious to moisture. Lighter colors, such as very light green and white, cannot be produced with graphite, if the latter is used in quantities sufficient to be definitely effective. For these shades, white lead and oil or white lead and zinc oxide in oil are better. Graphite contents below 10-12 per cent are usually not considered effective. Very light grays with 15 per cent graphite are now available, and darker grays with as high as 32 per cent (most blacks have only 30-31 per cent).



PAINTING THE DIESEL

Westchester Joint Waterworks No. 1, Mamaroneck, N. Y., uses green with black trim on its engines, air tanks, etc. Walls and ceiling are light gray. Here the paint problem is to use a material resistant to the softening action of oils and capable of withstanding heat and holding its color.

It is important on new steel surfaces to see that all mill scale is removed. Wire brushing and scraping must be resorted to, and often even these are not sufficient. If the surface is allowed to weather for a time, the scale will wear off. When rusting sets in, the steel is ready for painting. Rust can be removed by wire brushing and scraping. Some undercoats also have great penetrative ability and will cut through thin films of rust to form a firm bond beneath. Any thick rust coating should always be removed, however, as should oils, greases, moisture and surface dirt. Sometimes it is possible to paint surfaces normally moist by employing auxiliary fans to set up a current of air.

When steel is constantly wet or subject to acid or alkali conditions, as in pipes, pitch paints are most resistant and have sufficient penetrating power to fill pits. Early asphalt-base paints become brittle after becoming dry; newer ones with the base emulsified in water do not get brittle. Lead chromate salts added increase rust resistance. Usually it is applied in two coats, sometimes in the presence of some moisture.

It is not necessary to put on an intermediate coat of gray in producing a mill-white surface over red lead or red oxide paints—two coats of white are far better.

Indiscriminate addition of artificial dryers is particularly bad, for while they *do* speed drying, they also burn the life out of the paint. Excess use of thinners, such as turpentine, causes the paint to chalk too rapidly. Turpentine has a tendency to sweat weeks after the surface painted is dry. Paint manufacturers mix their paint carefully for specific conditions, in proper proportions. If these proportions are changed, the paint will prove unsatisfactory for the particular purpose.

Paints on metal should have sufficient elasticity to expand and contract with the metal, without scaling in the process. Some paints may show surface cracks that do not go through to the metal. This is caused by insufficient drying time on the first coat before the second is applied. The first coat must dry thoroughly, with proper hardness and toughness, before the second is applied.

This is one reason why linseed-oil house paint is of little value on machinery. It takes longer to dry, then when dry does not have proper characteristics. If it must be used, its surface should be sandpapered when dry, then covered by varnish-vehicle floor paint.

Boilers and Hot Surfaces

Hot surfaces—boilers, steam lines, etc., should be coated with insulating type paints, such as aluminum paint, for example. These will often decrease radiation of heat as much as 10 per cent. Obviously, the same paint would be unsatisfactory on a radiating surface. This should be coated instead with a flat paint or enamel, for these transfer practically all of the heat.

In painting boilers and other power plant equipment, good appearance and heat and oil resistance must be added to protection and light reflection. Lacquers,

brittle amberols, quick-drying resins and elastic quick-drying glyptol resins are good, where heat is not too great. The glyptol resin is very oil-resistant, does not discolor, has a high luster, and is easily applied over good previously painted surfaces. It dries dust-free in an hour and hard in four to six hours. Protection from rust must come, however, from a good chromate primer.

Many special heat-resisting paints have been developed. One, for example, with a pigment of ferric oxide, silica and alumina, resists heat, oils, gases, acids, alkalies, brine and abrasion. Several others may be mixed with aluminum to give a black coating next to the material and an aluminum finish, the combination being high in heat, acid and alkali resistance. One of these paints will withstand very high temperatures and may be brushed or sprayed on. One coat covers completely, and it may be applied to metals or concrete (to prevent disintegration). Another type of paint combines rubber, bitumen and benzol. This is especially good in resisting SO_2, chlorine, ammonia gas, vapors, brine and many chemicals. This finish is rustproof, very adhesive and very flexible. It is also a good electric insulator and resists dry heat to 392 deg. F. These paints are usually available only in black and darker colors. Still another paint is almost entirely elaterite, a hydrocarbon, with no carrying oils. The natural oil in the hydrocarbon acts as a binder and petroleum solvents are used to reduce the paint to a liquid for spraying or brushing. The solvents then evaporate, leaving a finish that is non-porous, acid and alkali resistant, capable of standing heat up to 500 deg. F., and highly resistant to electricity. It can be used on wood, iron, steel, concrete and other materials. Lubricating and insulating oils will, however, soften it.

Furnace walls should also be coated to avoid air infiltration through the setting. Usually a plastic bituminous product or some similar material is used for sealing.

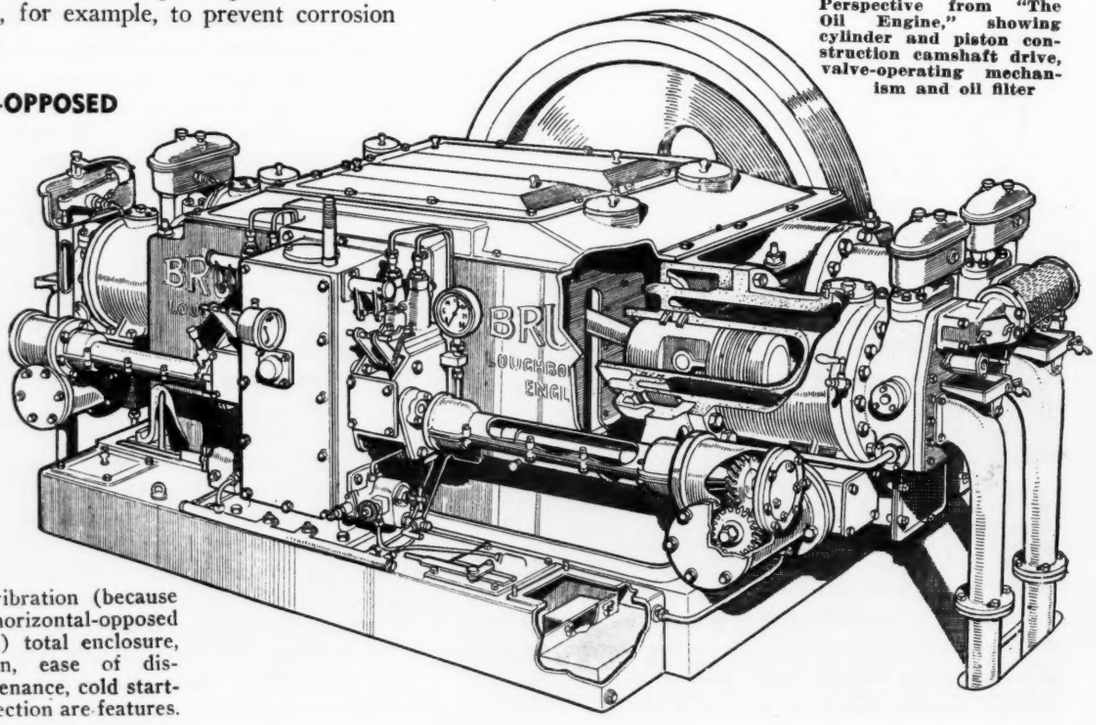
Coating materials described in these articles are almost all paints. There are also special protective coatings available, one, for example, to prevent corrosion inside boiler tubes.

According to THEO. J. DICK

These Are the Answers

to test questions on page 245.

1. The length, the number of degrees heated and the kind of material.
2. The fraction of its original length that a body expands when heated one degree.
3. $E = T\,C\,L$ (E = expansion, T = change in temperature, C = coefficient of expansion L = original length).
4. $160 \times .0000065 \times 200 \times 12 = 2.496$ in.
5. Invar.
6. Mercury has the same rate of expansion from its freezing point to its boiling point.
7. No.
8. Space is provided in boiler setting to permit the boiler to expand. Underground steam lines have expansion joints. When setting rails, space is allowed between each rail.
9. $(110 + 40) \times 7{,}000 \times 0.0000065 = 6.825$ ft.
10. Mercury.
11. The coefficient of expansion is different for different materials.
12. Conduction, convection and radiation.
13. The unit of heat measurement in English speaking countries. Roughly, it is the quantity of heat necessary to raise the temperature of one pound of water one degree Fahrenheit. More exactly it is 1/180 of the heat required to raise one pound of water from 32 deg. to 212 deg.
14. $(212 - 44) \times 10 = 1{,}680$ B.t.u.
15. The heat required to raise one pound of a substance one degree Fahrenheit.
16. That surfare which has water on one side and hot gases on the other. It is measured on the water side.
17. $\dfrac{10 \times (150 - 60)}{15 \times 0.1189} + 150 = 655$ deg. F.
18. The difference in temperature $\times$ weight of the substance $\times$ specific heat.
19. $\dfrac{4000 \times 210 \times 1 + 4000 \times 60 \times 0.1189}{4000 \times 1 \quad + \quad 4000 \times 0.1189} = 193.8$ deg. F.
20. $(2{,}000 - 70) \times 10 \times .24 = 4{,}632$ B.t.u.

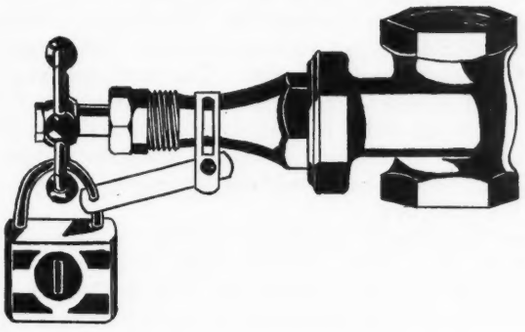


Perspective from "The Oil Engine," showing cylinder and piston construction camshaft drive, valve-operating mechanism and oil filter

HORIZONTAL-OPPOSED DIESEL

• MOST new diesel designs are verticals, but occasionally a horizontal is developed that appears to be of genuine interest. The Sterling crankless engine is one; this new English design, the Brush, is another. The perspective shows a 4-cyl., 160-hp. model installed at Downton Electric Light Co. as a hydro standby. Low headroom, compactness, reduced vibration (because of the balanced horizontal-opposed piston arrangement) total enclosure, pressure lubrication, ease of dismantling and maintenance, cold starting and variable injection are features.

PRACTICAL AIDS TO OPERATION



Lock Your Valves for Safety

CHILDREN PLAYING with a plant valve emptied my water reserve tanks, necessitating the shut-down of three boilers. A similar incident lost us 4,000 gal. of diesel oil. An unlocked steam valve on a steam line killed our second engineer working in one of the boilers. Then I resolved always to have valve locks on hand.

The device shown in the sketch is simple to make. It consists of a hose clamp attached to the valve body, to which is riveted a piece of iron serving as the connecting arm, with a padlock link passing through the hole in the link and through the valve handle, thus locking it securely. A safety-first device is better than a safety-first warning.

Vancouver, B. C. S. H. COOKE

High-Pressure Feeder for Boiler Compound

IN A 1,450-lb. steam plant, the older methods of feeding compound to boiler feed water were ruled out. However, it was desirable not to use a special pump unless necessary. The method shown in the diagrams was tried, with successful results.

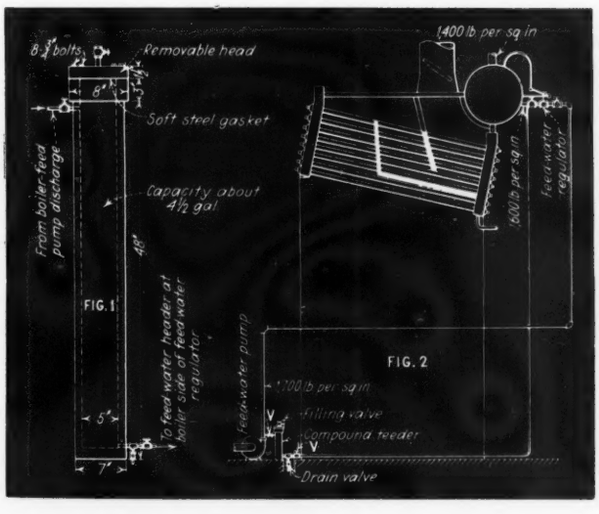
A piece of 8 x 51-in. steel stock was secured. This was put in a lathe and a 5-in. hole bored through it to within 1½ in. of one end. The open end was faced off square and a steel head plate made. A hole was drilled and tapped in the center of the plate for ¾-in. pipe. The cylinder was also drilled and tapped near the top and bottom for ½-in. pipe and then turned down to 7-in. outside diameter to within 3 in. of the top, as shown in Fig. 1. Eight ¾-in. holes were drilled in the head and cylinder, the latter being tapped. The space between the bolt holes on the face of the metal was serrated on both the cylinder head and inside of the plate head for a gasket surface.

A factor of safety exceeding 5 in all parts was used, assuming a pressure of 1,700 lb. per sq. in. Considerable experimentation has shown that a soft-steel gasket in the cylinder head gives best results. One of these has lasted several times as long as other types which were tried.

As in Fig. 2, the top connection of the cylinder is connected to the feed-pump discharge. The lower connection is piped to the feed-water line at the boiler inside the feed-water regulator. Under normal operation, the feed-pump discharge pressure is about 1,700 lb. and at the inlet to the boiler about 1,600 lb., the feed-water regulator causing a pressure differential to assure flow in the compound line. Pipe fittings in the ½-in. line were kept to a minimum, bends being used in their stead wherever possible to reduce friction drop.

Compound for 6 or 8 hr. of operation is dissolved in about 3.5 gal. of hot water. The two valves *V* on the cylinder are closed, and the plug in the top filling valve is removed. This valve and the drain valve are opened and the cylinder drained, after which the drain valve is closed and the cylinder filled through a funnel placed in the top connection. The filling valve is then closed, the plug replaced, valves *V* opened and the compound will then flow to the boiler.

Waterville, Me. HARRY M. SPRING, JR.

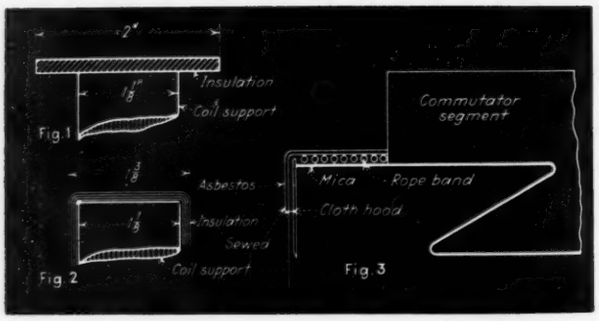


Rotary Converter's Operation Improved by Rewinding

A 500-KW. rotary converter tripped off the bus, and its armature was found to be grounded in three places. Insulation on coils, coil supports and under the supporting band was burned. When repairing the machine, it was desirable to make insulation as nearly fireproof as possible and to improve ventilation so that the coils would operate at a lower temperature than before the fault occurred.

The coils were sent to the repair shop and were insulated with mica tape. A mica cell was put on the slot-section of the coils and they were taped with asbestos tape, one-half lap. This constituted a fireproof insulation.

Directly under the bands were four coil supports, insulated as in Fig. 1. This insulation was removed and new insulation was wrapped around the iron coil supports to cover them completely, Fig. 2. The outside layer was asbestos tape, 1½ in. wide and made the insulation on these supports fireproof. This change in



the insulation also allowed a total of 2½ in. more space between the four coil supports to improve the air circulation around the coils and reduce their operating temperature.

At the front of the commutator, the cord band had been partly burned. This band and its cloth hood were renewed. The hood cloth was fastened to a ring about 6 in. inside the outer diameter of the V ring. To fireproof this insulation a wide piece of asbestos was pulled tightly over the other insulation, close to the commutator and extending over the outer edge about 3 in., Fig. 3. The outer edge was sewed to the cloth hood with strong twine to keep it from flaring out while the machine was running.

When winding this armature, care was taken to keep the coils straight and spaced evenly outside of the slots. A short piece of insulation, the same width as the coil, was placed between it and the coil support but not extending beyond the latter. Insulation between the bottom and top of coils was made of asbestos and was placed exactly over the coil supports and of the same width.

Insulation under the old bands extended ⅜ in. beyond them on each side. This was reduced to ¼ in. to allow a little more space for ventilation and bronze wire was used instead of steel for banding.

After the machine was assembled and on the line, a test showed strong air currents up through the coils, and the machine is now running much cooler than before it was rewound.

Buffalo, N. Y. F. D. BAIRD
Service Department,
Westinghouse Electric & Mfg. Co.

How to Maintain Centrifugal Pump Efficiency

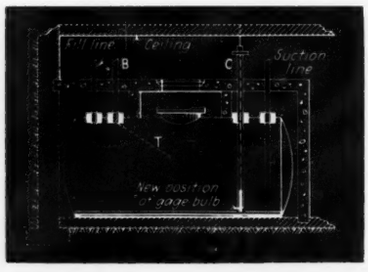
AS A RULE, when an operating engineer discusses the efficiency of a centrifugal pump, he thinks principally of impeller-vane and case-passage design, elements which are under control of the pump manufacturer. Too often he forgets that proper alignment of the unit, amount of wear in impeller and case rings and tightness of packing in stuffing boxes have a considerable influence on the power required by the pump. Recently, I found that the efficiency of a 4-in., double-suction pump could be raised almost 4 per cent by loosening the stuffing-box packings and yet maintaining the packing tight enough to seal against air leakage into the suction chambers. By removing all but one ring of packing from the stuffing boxes and filling the space with a stiff grease, efficiency was raised another 2 per cent. The grease served as a satisfactory seal against air leakage into the suction. Improvement in efficiency will vary with different sizes of pumps and will depend upon conditions under which they operate.

In another case, it was found practical to change the type of wearing rings and provide them with an annular groove into which grease could be packed from outside while the pump was in operation. This reduced leakage between discharge and suction chambers and increased the efficiency several per cent. Clearance between the casing and impeller rings will normally permit a fairly large volume of water to pass, due to difference of pressure between suction and discharge. Anything done to reduce this loss of water without increasing friction will raise the efficiency.

Many centrifugal pumps are installed with an elbow directly at the suction. Where space conditions permit, a straight run of pipe should be provided between the suction elbow and pump suction to smooth out the liquid flow before it enters the pump and thus improve efficiency. It is always best to have the water or other liquid enter the pump suction as smoothly as possible. An attempt to insure this type of setting is seen in modern pumps where the suction nozzle has been lengthened considerably.

In a large chemical plant, a 3,000-g.p.m. pump operating against 150-ft. total head had been working satisfactorily for over five years. After two new shaft sleeves were installed, it was found that the pump capacity dropped off over 10 per cent although the power consumption was about the same as before the change was made. Investigation showed that the shaft sleeves were not tight on the shaft and air was leaking into the suction chamber under them, thus reducing capacity, pressure and efficiency. When the shaft-sleeve hubs were counterbored and the spaces filled with shellac, air leakage was stopped, and the original rating and efficiency were obtained.

New York, N. Y. FRANK A. KRISTAL,
Mechanical Engineer.



Protects Oil-Tank Gage Against Surges

WHEN OIL in the storage tank in the diagram was withdrawn to below the center of the tank, the boiler-room indicating wall gage would register empty. Upon investigation, the copper tubing *T* was found bent into the position shown. When oil was first used, the storage tank was filled by gravity from tank trucks at street level, and no gage trouble was encountered. When the oil was pumped to the storage tank, it caused surges that bent the tubing and rendered the wall gage inaccurate.

To overcome this difficulty, the hydrostatic bulb for the gage was disconnected, the concrete around the pipe being broken sufficiently to permit doing the work. Vent line *C* was disconnected at a convenient ell above the tank and reconnected where the oil gage was formerly connected. A man entered the tank and screwed a piece

of pipe into the back side of the bushing of pipe *C* to act as a conduit for the bulb and tubing of the gage. The hydrostatic bulb was slipped through the coupling of the pipe and lowered to the tank bottom. The bushing was then tightened into the pipe coupling and the gage line completed. The fill and suction lines were not changed.

Brooklyn, N. Y. WILLIAM ANDERSON

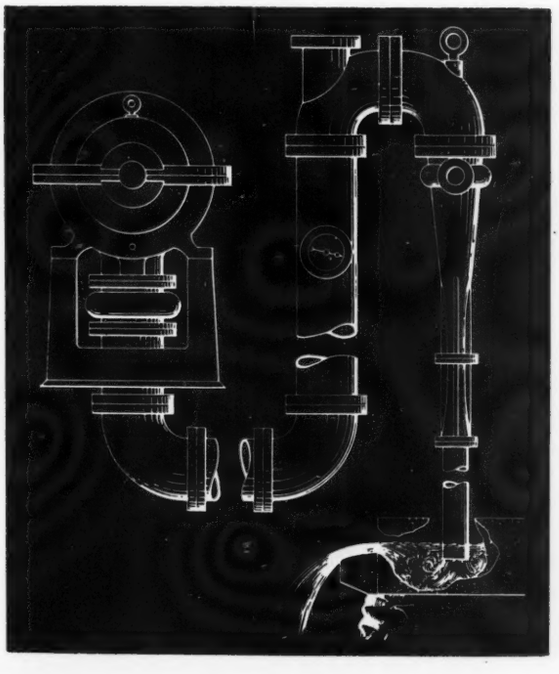
Recirculates Brine to Dissolve Calcium Chloride

THE USUAL METHOD of mixing calcium chloride into a brine solution is by either stirring it direct into the brine or by dissolving it in hot water and then mixing in. In the plant where I am employed we use a different method that not only gives better results, but is simple to operate.

On the discharge side of the brine pumps, we disconnected a thermometer and inserted a ½-in. nipple and angle valve. This thermometer was not necessary for operation, as there is another on the same line where it leaves the brine tank. When calcium chloride is to be dissolved into the brine, four ice cans in the center of the brine tank are removed. Over this space is placed an empty barrel with holes punched in the bottom and part way up the sides.

The barrel is filled with calcium chloride and a pipe run from the valve at the brine pump into the top of the barrel. Flow of brine into the barrel is controlled by ½-in. globe valve at the end of this pipe. When all the calcium chloride is dissolved, the valve at the brine pump discharge is closed, the pipe is disconnected and the ice cans are put back into place.

Chicago, Ill. ABE ROCKLIN



Vacuum Problem

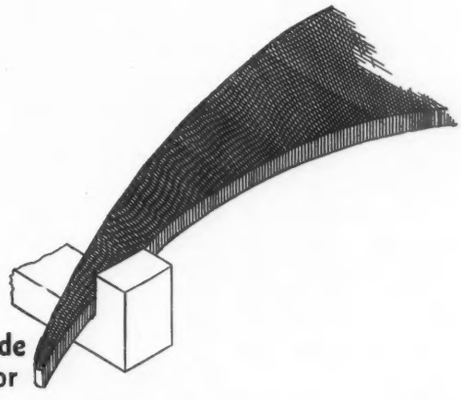
A 500-KW. turbine-generator set was served by a barometric condenser which failed to produce better than 22 in. Hg of vacuum. Conditions were favorable (or should have been) for a much greater vacuum; cold water, full 34-ft. barometric leg and no overload.

A ¼-in. cock, at *A* in illustration, had been tapped into the exhaust of the turbine for a gage, but the gage had been removed. One watch engineer, without any reason, opened this cock. The vacuum dropped about 4 in. momentarily, then shot up to 26 in. After a period of perhaps half an hour, the vacuum had again dropped to 22 in. This stunt could be repeated time after time.

The hotwell, built of concrete, was between two waterwheel tail-races, one of the most dangerous and inaccesible spots imaginable. Even though served by an iron ladder it was a hazard to inspect this concrete box.

But, one day, the hotwell *was* inspected and the cock opened to admit air. The vacuum went up and so did the water in the hotwell, the air admitted allowing the water in the leg to drop suddenly and so raising the hotwell level. Normally the seal was only 4 in. This was not enough, so flash boards were installed in the overflow. This cured the trouble.

Lawrence, Mass. C. J. WILDER



Old File Made Key Extractor

LIVES there a mechanic who has not been up against frozen gib keys, driven home without a coating of white lead; with heads chewed up by futile efforts to drive out the key with a cold chisel, or worse still, with the head broken off.

Having thirty machines to take down every year, each with forty gib keys in the cams, spiral and spur gears and movement arms, I made the device shown in the figure from an old file. By the use of this tool, gib keys are pulled about as fast as one may draw nails with a claw-hammer. Gib keys are often situated where no other tool or device may be used.

Vancouver, B. C. S. H. COOKE

Testing Efficiency of Laminated Brush Contact

TO TEST the efficiency of contact between laminated brushes and a solid contact, cover the contact with tin foil and close the circuit breaker. Then open it immediately and examine the tin foil. When the fit between the laminated and solid contacts is good, the tin foil will be marked with parallel lines where the laminations bear. If the pressure is excessive at any point, the tin foil will be cut through. When the laminations do not bear at any point, the tin foil will not be marked. This test will show the conditions of the contacts, and the laminations can be trimmed up with a fine file until a good fit is obtained.

Welwyn, Garden City, England W. E. WARNER

CURRENT COMMENT

Many Corliss Engines Ran on Air

THE ITEM by Mr. Hayward in the March number of *Power,* about running a Corliss engine with compressed air, calls to my mind a time long ago when it looked as if there might be a good many Corliss engines running with compressed air.

Around 1890, there was no such thing as electrical transmission in the Far West, and compressed air was used for power transmission in a number of cases, with every prospect, so far as then known, that its use would grow. One famous plant, on which I worked as an apprentice, was installed in 1890 by an early pneumatic engineer, Edward A. Rix, at the North Star Mine near Grass Valley, Placer County, Calif. A Pelton impulse wheel was located at a waterfall and directly connected to a large air compressor. A compressed air pipeline ran from this point to the mine many miles away. At the mine were hoisting drums driven by Corliss engines operated by the compressed air. The air was heated before entering the Corliss cylinders by heaters fired with wood from the surrounding forests. This multiplied the power obtained from the compressed air in proportion to the increase of absolute temperature. The entire plant was constructed with every attention to efficiency, and gave a creditable performance. A few similar plants were constructed at other places, and so far as could be seen, the system bid fair to grow into considerable use. Then electrical transmission came along, and Corliss engines operated by compressed air became the rarity that Mr. Hayward's article indicates.

West Lynn, Mass. SANFORD A. MOSS
Thomson Research Laboratory

"Bottle Neck"

I WOULD LIKE to add a little comment to the Editor's excellent page in the March number entitled "Bottle Neck." Such a clear statement of facts certainly cannot be misunderstood, and unquestionably you will receive amplified opinions from those who have heretofore given you their views on this subject. Each will undoubtedly tend to justify his own position. It is just possible that by getting all of the facts out into the open, the other fellow's viewpoint can be given more consideration, and by a rearrangement of positions, some satisfactory solution will result.

It doesn't require an intensive study to be convinced that business is largely conducted on credit. An ever-increasing amount of business has been generated by means of sound deferred payment merchandising. The power to break this "bottle neck" rests in the hands of the power equipment manufacturers who must sooner or later realize that if they want to increase their business and profits, they must be in a position to extend to their prospects a plan whereby the cost of the equipment can be paid at approximately the rate of saving.

The equipment manufacturers who have acknowledged these facts have made considerable headway where the extension of credit has been intelligently handled and the terms of payment within reason. There are few businesses, if any, making a manufacturing or merchandising profit that are not required to assume credit responsibility. Any manufacturer who is turning out a good product will find any number of plans available to him so that his own funds and his own credit need not be used for the financing of such contracts, but can be left free and unimpaired for manufacturing purposes.

A consulting engineer who looks a little closer at this picture, with due consideration to the interests of those with whom he has contact, would find, much to his surprise, that the strings and red tape do not exist as much in practice as in theory. If the manufacturers of whatever equipment the engineer selects are in sympathy with such a program and will cooperate by assuming their proportionate share of the responsibility, which is indeed small, and if their equipment will do the job, it would be a simple matter to find funds whereby a deserving industrial concern could carry out a much needed and profitable modernization program.

New York, N. Y. L. C. HERRICK
Eastern Manager,
Walter E. Heller & Co.
(Commercial Bankers)

More About Blowdown

UNDER this heading T. P. Browne raises some interesting points in the January, 1934, number. As he states, the question of intermittent vs. continuous blowdown cannot be answered by a generalized reply. However, experience has developed certain general rules, the application of which to a special case will usually make it relatively easy to determine which should be used.

The feed-water treatment, suggested by Mr. Browne, in which no sludge-, scale- or suspension-forming material enters the boiler, gives the simplest case. Having only soluble salts to contend with, we have only to determine the maximum concentration that can be carried without trouble from carryover, and proportion our blowdown so the concentration in the boiler will be kept below this point. Whether the continuous or intermittent system is more suitable will depend on the quantity required.

To illustrate: Assume that a maximum concentration of 200 gr. per gal. can be allowed in the boiler. With continuous blowdown, the concentration need only be removed at the same rate that it is brought into the boiler by the feed water, but with one blowdown per 8-hr. watch the concentration must be reduced sufficiently below 200 gr. per gal. at the end of the blow so it will only build up to this at the end of an 8-hr. period.

Where the blowdown is 1 per cent of the total feed and not over 4 per cent of the water capacity of the boiler per watch, as would be the case with an H.R.T. boiler, the difference in the quantity of blowdown would be small, about 3 per cent. However, if the required blowdown is 4 per cent of the total feed and the quantity per watch 30 per cent or more of the water capacity of the boiler, as in the case of a water-tube boiler, one blowdown per watch may require a total quantity 20 per cent greater than continuous blowdown. In addition to this a heat exchanger can be installed with the con-

tinuous blowdown, which, with 70 deg. makeup water and a steam pressure of 150 lb., will recover heat from the blowdown equivalent to about 1 per cent of the boiler output.

Often it proves impracticable to remove all of the sludge-forming materials by treatment outside the boiler, which makes the problem more complicated. When the feed water entering the boiler carries 4 gr. per gal. or over of total solids, and the sludge-forming material is less than 50 per cent of the total solids, continuous blowdown will usually be found most satisfactory and economical for the following reasons:

First: A higher average concentration can be carried in the boiler without danger of carryover, thus reducing the quantity of blowdown.

Second: A continuous blowdown is more effective for removing suspended matter, if correctly located in the boiler circulation, than the usual blowdown from the mud drum.

Third: Continuous blowdown properly controlled will maintain much more uniform conditions in the boiler which tend to more efficient boiler operation.

In case the sludge-forming or suspended matter is 50 per cent or more of the total solids in the boiler water, we must resort to some method other than blowdown if satisfactory results are to be obtained. For this condition the use of a sludge deconcentrator offers many advantages. This is a patented device which in its commercial form consists of a by-pass circulation from a point near the bottom of the upper drum or drums of a boiler, to the usual blowoff connection from the mud drum of the boiler, in which a vertical settling chamber is placed and through which circulation is secured by thermosyphonic action.

Experience has shown that with a deconcentrator of proper size, the concentration of sludge or suspended matter in a boiler can be kept below that which will cause priming or deposits inside the boiler and that the total blowdown required will be from one-tenth to one-half that required by the most efficient continuous blowdown system. The concentrated sludge is blown off from the bottom of the settling chamber at intervals.

Thus, as shown by the illustrations above, we may set the limits for the use of the various methods of blowdown about as follows: Continuous blowdown is seldom justified where total blowdown is less than 3 per cent of the water evaporated. Where blowdown is over 3 per cent, and the concentrations to be removed are all or largely soluble salts, continuous blowdown with or without heat recovery should be considered. In boilers where sludge-forming material constitutes 50 per cent or more of the total solids in the feed water and the total concentration is 4 gr. per gal. or over, the use of sludge deconcentrators should be given consideration.

Of course, we all agree that it is desirable to remove sludge-forming material from the makeup water outside the boiler so far as it is practicable. Experience has shown, however, that with many raw waters a treatment that will completely remove them will require the addition of so large a quantity of soluble salts to maintain a safe sulphate-alkalinity ratio that the total concentration will be raised to an extent that will require an unreasonably large blowdown loss. Therefore, the most economical, safe water treatment should be given careful consideration before deciding on type of blowdown.

New Haven, Conn. WM. W. GAYLORD,
Consulting Engineer.

Soot-Blower Maintenance

I READ with interest the article on soot blowers in the February number of *Power*. Although initial correct installation is of importance, since the elements are exposed to high and alternating temperatures, warping and displacement of the nozzles is always possible. When the nozzles become displaced, blowing becomes inefficient and erosion of the boiler surfaces may result due to the direct impingement of the steam. The condition of the elements and position of the nozzles should be checked each time the boiler is inspected. The nozzles themselves should also be examined. If the nozzles become enlarged they will waste steam and the steam blast will be less effective. Wear and enlargement of the nozzles is bound to occur, due to the continual erosion of the steam and the abrasive action of the flue dust, and other causes.

Efficiency of blowing also depends on a sufficiently high steam pressure, therefore pipe of ample size and full opening of valves during blowing become important. Considerable steam pressure may be lost through undersized piping or through the use of piping which has become dented or otherwise mechanically damaged to reduce its cross-sectional area.

Frequency of operation of these blowers depends largely on the class of fuel used, but also on other factors such as the efficiency of combustion and design of the plant. Blowing should not be delayed until deposits build up too much, otherwise deposits may be blown off in chunks and clog the spaces between tubes. In many plants, blowing every 8 hr. is adopted, but this time could in many cases be reduced with advantage, the increased efficiency of the heat transmission outweighing the slight increase in steam consumption.

Efficient blowing has a great bearing on efficient heat transmission. The increased boiler efficiency will usually more than repay the trouble and cost in maintaining the equipment in first-class condition.

Garden City, Herts, England. W. E. WARNER.

Cast-Iron Base Fails On Heating Boiler

AN UNUSUAL ACCIDENT occurred some time ago to a heating boiler in an office building near the water-front of an eastern city. This boiler was of the usual cast-sectional type for low-pressure heating boilers.

It so happened that several times each year, when there was an exceptionally high tide, the salt water would flood the basement where the boiler was installed. The water often reached a depth of several inches, but seldom reached the grates, so little thought was given to the boiler supporting base.

The boiler had been in operation many years, and careful attention had been given to its pressure-retaining sections. The cast-iron frame around the ash pit which supported the weight of the boiler was not looked at very closely. One day when the fireman was beside this boiler, the base gave way. The boiler tipped over, severely scalding him. The corrosive effect of salt water and wet ashes had gradually wasted away the base. For this reason, such an installation should receive careful attention.

Cleveland, O. M. E. WAGNER

SOLVING SIMPLE EQUATIONS

By C. R. CHADBOURNE

This is a sequel to the article "The A.B.C. of Algebra," which appeared in the March number. If you have not read that article please go back to it first. These are designed particularly for readers who have come into the power field without a background of technical education. Mr. Chadbourne's explanations can easily be followed by any man who understands simple arithmetic.

THE purpose of algebraic equations in engineering is to furnish rules or methods for making useful calculations. For example, the area of a circle is the square of the radius multiplied by 3.1416. This is expressed very simply by letting a stand for area, r for radius, and the Greek letter π (pronounced "pie") for the number 3.1416. Then we have

$$a \text{ equals } \pi r^2.$$

This is an algebraic equation.

The circumference of a circle is 2 times the radius times π.

$$c \text{ equals } 2\pi r$$

The capacity of a vertical circular tank is the area of base times height. Letting v stand for volume or capacity, we have

$$v \text{ equals } \pi r^2 h$$

The capacity of a cubical tank or bin is the cube of the length; that is

$$v \text{ equals } l^3$$

It is clear from these illustrations that algebraic equations are time-savers. We shall now discuss methods of solving such equations. In most practical work, all the quantities in the equation are known except one, and the object is to find the value of the one unknown quantity. For example, we may know the height and radius of a circular tank and wish to find the capacity. The equation for capacity of a circular tank gives us the rule for solving the problem. We put the numbers in the equation in place of the letters, then do the work as the equation indicates.

If the radius of our tank is 5 ft., and the height 8 ft., then for this particular tank

$$v \text{ equals } 3.1416 \times 5^2 \times 8$$

It is necessary to know certain rules that must always be observed in solving equations.

First Rule: Whatever is done to one side of an equation must be done to the other side.

If this rule is violated, the equation is no longer true. This rule can be illustrated best with numbers.

Take the equation:

2 plus 3 equals 5

We can add the same number to both sides of the equation. Let us add 4, then we have

2 plus 3 plus 4 equals 5 plus 4,

which is true. But if we add 4 to one side only, we get

2 plus 3 plus 4

which does not equal 5.

Subtracting 3 from both sides, we get

2 equals 2

Multiplying both sides by 2, we get

4 plus 6 equals 10

Take the equation

a equals b

Multiply both sides by c. Then

ac equals bc

Divide both sides by c, then

$$\frac{a}{c} \text{ equals } \frac{b}{c}$$

Square both sides, then

$$a^2 \text{ equals } b^2$$

Transposing is subtracting the same number from both sides of an equation.

Take the equation

a plus b equals c

Subtracting b from both sides. we have

a equals c minus b

So when b appears on the right side of the equation it has the minus sign.

Illustrating this with numbers, let

a equal 2, b equal 3, c equal 5

2 plus 3 equals 5

Transposing 3, we have

2 equals 5 minus 3

When 3 appears on the right side, it has the minus sign. This gives us our second rule.

Second Rule: Any term in an equation may be transposed by changing its sign.

Clearing an Equation of Fractions

Third Rule: To clear an equation of fractions, multiply both sides of the equation by a number that will contain the denominators of all the fractions.

For example, take the equation

$$\frac{a}{2} \text{ equals } \frac{b}{3}$$

Multiplying both sides by 6, then we have:

$$\frac{6a}{2} \text{ equals } \frac{6b}{3}$$

or, $3a$ equals $2b$

Take the equation

$$\frac{a}{b} \text{ equals } \frac{c}{d}$$

The quantity bd contains both denominators. Multiplying both sides by bd, we have $\frac{abd}{b}$ equals $\frac{cbd}{d}$ or, ad equals cb, since abd divided by b equals ad, and cbd divided by d equals cb.

We shall now apply these rules in solving some simple equations:

If $2x$ equals 10, what does x equal? Dividing both sides by 2, we get x equals 5.

If a plus 3 equals 10, what does a equal? Subtracting 3 from both sides, we get a equals 7.

If b equals 3×2^2, what is the value of b? 2^2 equals 4, and 3 times 4 equals 12; b equals 12.

Examples to be solved:

1. a plus 5 equals 15, what does a equal?
   Answer—10.
2. $\frac{a}{3}$ equals 12, what does a equal?
   Answer—a equals 36.
3. $3b$ equals 21, what does b equal?
   Answer—b equals 7.
4. c equals $2\pi r$. If r equals 3 and π equals 3.1416, what does c equal?
   Answer—c equals 18.8496.
5. v equals l^3. If l equals 8, what does v equal?
   Answer—v equals 512.
6. a equals πr^2. If r equals 3, what does a equal?
   Answer—a equals 28.2744.
7. v equals $\pi r^2 h$. If r equals 4, h equals 3, what is the value of v?
   Answer—v = 150.7968.
8. For total pressure on piston, we have the equation P equals $\pi r^2 p$, in which p is pressure per square inch. If r equals 6 and p equals 50, what does P equal.
   Answer—P equals 5,654.88.
9. In the equation v equals $\pi r^2 h$, if v equals 251.328, r equals 4, what does h equal?
   Answer—h equals 5.

B. C. BOILER LEGISLATION

British Columbia will shortly have boiler legislation similar to that now in force in Ontario, Quebec and New Brunswick, if the petition of over 300 leading firms is passed by the B. C. Government. The petition asked for amendments to the present Boiler Inspection Act, compelling every company using a boiler to pay substantial fees for government inspection, in addition to further inspection fees if insurance is taken out. It is suggested that companies having inspections by the insurance company should be exempt from government inspection. No decision has yet been reached.

SMOKE ABATEMENT ACTIVITY

Boston

A vigorous effort to re-establish the complete organization for smoke abatement which recently existed at Boston manifested itself in the Massachusetts Legislature. A number of witnesses appeared in favor of the measure, including leading representatives of the medical profession, who emphasized the physiological dangers of impure air and the property damages caused by smoke in metropolitan areas. The bill provides for increased inspection personnel, an advisory countil to serve without pay and re-establishes jurisdiction of the division over fuel-burning plant designs with regard to smoke prevention.

Representative Sullivan stated that with the present inspection force of three men, the Boston district has a population of 595,080 per inspector and an area per inspector of 83.1 sq.mi, whereas in New York the corresponding figures are 119,416 and 4.1; in Chicago, 73,876 and 4.3; Cleveland, 89,500 and 6.1; St. Louis, 119,885 and 8.7; Pittsburg, 166,375 and 11.7; and Cincinnati, 103,050 and 18. In the last year (1931-2) before the Legislature curtailed the inspection in the Boston area, the division detected 2,959 violations, investigated 556 complaints, held 352 public hearings, issued 71 orders for improved operation of plants, and carried 8 cases to the courts. Prof. C. H. Berry of the Harvard Engineering School and a former member of the advisory board, advocated the bill, and Fred M. Beckwith, for the Boston Oil Burning Associates, stressed the economic waste of imperfect combustion, declaring that with proper engineering advice little trouble comes from smoke.

Chicago

Civil Works Administration funds have made it possible for the City of Chicago to employ a large corps of engineers to attack the smoke nuisance, this force to supplement activities of the Department of Smoke Inspection and Abatement under jurisdiction of Deputy Smoke Inspector Frank A. Chambers.

Main objectives of this campaign are: To detect smoke violations and by scientific analysis determine the percentage of air-pollution chargeable to the various types of furnaces. To advise owners whose plant violates City Smoke Abatement Ordinance as to corrective methods. To make a survey of all heating power and industrial plants for the purpose of suggesting to owners improvements advisable to be made in the boiler room for the purpose of insuring against the emission of any smoke and for more economical operation of the plant.

150 engineers out of a total quota of 500 are now in the field making smoke observations and instructing operators.

Cleveland

At a recent meeting of Smokeless Salesmen in Cleveland, W. E. E. Koepler, Secretary of the Pocahontas Coal Operators' Association, said: "I want to emphasize the importance of adopting a suitable firing method and effectively advocating it through the trade. The Pocahontas Operators' Association is printing the Fourth Edition of its cards and leaflets explaining the Conical Method, which have been appreciated very widely by dealers and customers. It is distinctly suited to true low-volatile coals and will not work with substitutes."

Hudson County, N. J.

Over a half million dollars in cash has been saved by Hudson County, N. J., fuel users as a direct result of smoke abatement activities, says Chief Smoke Abatement Engineer William G. Christy of the Department of Smoke Regulation.

"In 1933 the saving in fuel amounted to $224,000. In 1932 it was $187,000, and in 1931, the first year of smoke abatement here, it was $120,000, a total for three years of $531,000.

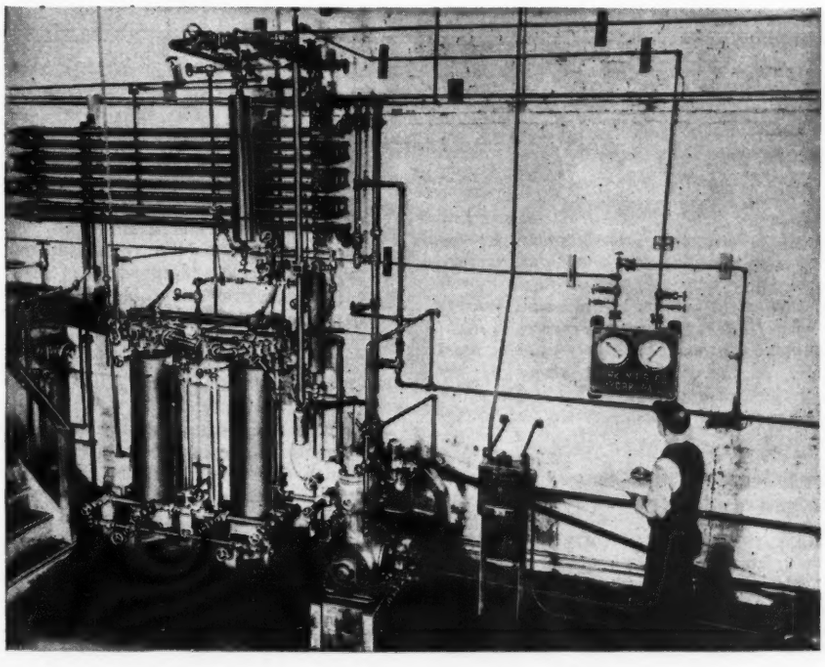
"These figures," Christy points out, "represent the cost of fuel that would have been burned and would have been necessary to buy if smoke, which is unburned carbon, had continued to pour from stacks at the rate it did when the war on smoke started.

"Every new coal stoker, every new oil burner and every new part of fuel-burning equipment installed in Hudson County in the past three years had first to be okayed by smoke department engineers and a permit issued before operation could begin."

Cincinnati

Frank H. Lamping, supervisor of the Smoke Abatement League, stated in his annual report that smoke abatement activity there has reached a level plane, if not a declining one. Home and apartment smoke showed a material increase during the year, due to the use of higher volatile coal, purchased because of reduced incomes. They have been forced to purchase the cheapest fuels available, so the job of educating the public to the need for abatement may have to be begun all over again, although the League has required use of coals producing less smoke in suitable cases.

Some 98 complaints were investigated as nuisances and 11,083 observations made of stacks in central districts, which resulted in 478 contacts to reduce smoke. Much contacting is done by telephone at the time the violation occurs. For the year 1932-33, a study showed reduction of 8.7 tons per mile of soot and smoke pollution over the preceding period.



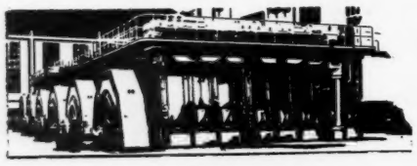
TESTING REFRIGERATION LUBRICANTS

Part of a research set-up at York Ice Machinery Corp. for service-testing lubricants under normal and abnormal conditions met in refrigeration equipment. One of the results shown so far is that ordinary lubricating oils, under conditions met in mechanical refrigeration, tend to create non-condensable gases which accumulate in the condenser and increase head pressure

Arc-welded Pressure Vessel

One of the first large pressure vessels ever built of arc-welded stainless steel, a fractionating tower for the distillation of fatty acid, has been completed by Foster Wheeler Corp. at its Cleveland shops. The tower, built in two sections, is 59½ ft. high and 6½ ft. in diameter, and was made of 18-8 stainless steel. Shell plates are ¾ in. thick, with double V-type horizontal welds. On completion it was tested with 25 lb. air pressure after filling one-third full with water. Shielded-arc welding was used with "stainweld A" electrodes.

READERS' PROBLEMS



QUESTIONS for Our Readers

Gear Drives Wear Rapidly

QUESTION 1

WE HAVE *several gear drives that give trouble and get noisy from rapid wear. To remedy these difficulties, a change to non-metallic pinions is being considered. If this change is made, will it be necessary to use gears and pinions with wider faces than those of the present gears? If so, how much wider? The load is very irregular. I would also like to have* POWER *readers' opinions of the possibility of this change proving a cure for the trouble.*
—L. R. S.

Diesel Noise and Vibration

QUESTION 2

TWO 150-HP. *diesel-generator sets on poured concrete foundations without isolation supply power for our factory. We have just rented space on the floor over the engines, and the new tenants object to the noise and vibration of the engines. What is the best and cheapest way to eliminate the trouble?*
—P. T. N.

Suitable answers to these questions from readers will be paid for if space is available for their publication.

Melting Babbitt Out of Bearings

IT IS CUSTOMARY *with us to use the acetylene and oxygen blow-torch for melting the babbitt out of old bearings. The ignited stream of gas blows directly against the babbitt. This practice has been questioned, and the objection is that the high temperature of the flame will injure some of the elements in the babbitt. We have also been advised to discontinue this practice and melt babbitt in a forge or with a flame which is not as high in temperature as the oxy-acetylene. We use what is known as genuine babbitt metal.* I. S. E.

A very high-temperature flame should not be used to melt the babbitt out of old bearings as there is danger of burning the metal and oxidizing the elements that have a low melting point in the babbitt. For example, playing a high-temperature flame on a babbitt metal containing zinc is likely to oxidize the zinc, unless proper care is taken when applying the flame. As is generally known, babbitt metal can be burned when heated in a pot if its temperature is allowed to get too high. There should be no objection to playing the flame on the bearing shell to melt the babbitt out of it, provided the flame is kept moving over the entire surface so it does not overheat any part. An ordinary gasoline torch, because of its lower temperature and less concentrated flame would probably be preferable to using an acetylene and oxygen torch to heat the bearing shell.

Testing for Sulphates

WHAT IS METHOD IN TESTING FOR SULPHATES?—*As a subscriber to* POWER *for many years, I wish you would give me assistance in the following: Recently a test kit was demonstrated to me for which the claim was made that all sulphates in raw, treated and boiler water could be determined accurately in less than ten minutes (firm is out of business now), benzidine, pH indicator and caustic being used as reagents. Could you explain to me in detail the various steps in making this test and also how I can check the strength of the reagents used for grains per gallon? Could you refer me to any reference books wherein I could study up on this test, both in practice and theory? I could use this test daily to great advantage. Any help you can give me will be greatly appreciated.*
H. E. H.

[The following reply was prepared for POWER by William J. Ryan of the Water Service Laboratories, Inc., New York City.]

It is difficult to tell from the description exactly what this test set consisted of. However it appears as though it was based on the so-called "Raschigs method" for volumetric determination of SO_4 by the use of benzidine hydrochoride.

LaMotte Chemical Products Co., Baltimore, Md., makes a testing kit for determining sulphates in water by a method in which benzidine is used, and it is probably the same or similar to the test Mr. Howind has in mind.

A detailed description of how the reagents are prepared and how these tests are made would be too lengthy to give here, but complete information can be found in "Standard Methods of Chemical Analysis" by W. W. Scott; and in W. T. Hall's translation of "Analytical Chemistry" by F. P. Treadwell.

Another widely used and quite simple method for determining sulphates in water is by means of the turbidimeter. Barium chloride is added to the sample of water and it combines with the sulphates to form a finely divided insoluble precipitate of barium sulphate. The degree of turbidity produced in the water by this precipitate affords a measure of the amount of sulphates present, and is gaged by means of a turbidimeter which can be obtained from any concern that makes laboratory equipment, who should also furnish instructions.

While the turbidimetric method is simple, it may be inaccurate under certain conditions, and before deciding to use it, it might be advisable to have tests made by a competent industrial chemist to see if the method gives satisfactory results with the water involved in this case.

Corrosion in Condensate Return Line

ANSWERS to March Question 1

THE QUESTION

I AM *experiencing considerable trouble from corrosion in the condensate return line from a water heater. The heater is supplied with steam from our heating boiler. Boiler feedwater receives a light treatment of soda ash. Corrosion is most severe in the piping just ahead of the heater condensate trap. What is the probable cause, and what can I do to stop it?*
—O. N. R.

Vent Heater to Remove Oxygen and CO_2

I HAVE just completed correlation of the data from an investigation of corrosion in the heating systems of 75 different buildings in principal cities of the United States, and in which corrosion in the condensate return lines of 14 steam-heated water heaters was also studied. Upon the basis of these results and from the superficial information contained in the question, the following answers are submitted:

The corrosion manifested is very probably due to oxygen and (or) carbon dioxide dissolved in the condensate. They may be introduced in the steam supply, or oxygen may seep into the system during non-operating periods. Regardless of their source, however, each is capable of causing active corrosion.

The expedients which may be used as remedial measures are:

1. Prevent infiltration of air if the heater operates intermittently.
2. Improve degasification of the feed water and use a chemical for water treatment which contains no carbon dioxide.
3. Vent the heater to prevent accumulation of non-condensible gas entrained with the steam and thereby lessen their solution in the condensate.
4. Introduce a suitable inhibitor such as oil or sodium silicate into the steam just preceding the heater.
5. Use corrosion-resisting pipe materials such as copper-bearing steel.

Unless it is definitely known which gas is the chief offender and from what source it is derived, it is impossible to state which expedient would be the most beneficial. Until this has been determined, however,

it is quite likely that the use of one or more of these measures will afford considerable relief.

Detroit, Mich. L. F. COLLINS,
Chemist,
The Detroit Edison Company.

Stray Currents Increase Corrosion

THE MOST PROBABLE causes of corrosion in the condensate return lines of heating systems are the presence of dissolved oxygen and carbon dioxide in the condensate, dissimilar metals in contact, the hydrogen ion concentration of the condensate, its conductivity and the magnitude of the stray electric currents which are usually to be found on pipe lines in basements, particularly those near electric motors or other electrical equipment.

The presence of dissolved oxygen is due to the natural exposure of water and air. In modern boiler plants deaerating feedwater heaters are used to eliminate the air and thus the oxygen from the boiler feedwater. In small plants where equipment of this nature is not used, there is bound to be oxygen present in the steam and condensate since it is present in the feedwater. Oxygen dissolved in condensed steam is one of the most important contributory factors in causing corrosion.

In producing steam from feed water containing carbonates, as in this case, there is a normal breakdown of these carbonates resulting in the formation of carbon dioxide which goes out with the steam, and later dissolves in the condensate. According to the electrochemical theory of corrosion, the only direct part taken by carbon dioxide is to decrease the pH value of the resulting solution, or in other words to increase the hydrogen ion concentration. If carbon dioxide is present in sufficient quantity, the hydrogen ion concentration may become so great that the protective film of atomic hydrogen on the surface of the iron might then be changed to a molecular state and so bubble off as a gas, thus providing an additional method whereby the all important protective coating may be removed.

It has been observed that corrosion is more serious just ahead of the trap on the condensate line. Since the metal of which the trap is made is probably not of the same throughout as the metal in the return line, there may be, in addition to the above factors, corrosive action due to dissimilar metals in contact. As is sometimes the case, parts of traps are made of brass. If this is true in this system, the rate of corrosion of any iron in close proximity to the brass wil be approximately doubled, while the rate of corrosion of the brass will be greatly reduced.

This electrolytic action is accompanied by a flow of current through the metal from the region where hydrogen atoms are collecting to the region where the iron is going into solution. It is possible for the magnitude of this current to be increased somewhat by stray electric currents, and this will serve further to increase the corrosion rate. If the hydrogen which is plating out due to this electrolysis is removed by oxygen or other means, corrosion will continue at a comparatively rapid rate in this region.

The amount of condensate present in the return line in the vicinity of the trap is probably greater than in the rest of the system, and this will increase the area over which the corrosion action can occur, as well as provide all the necessary contributory factors in increased quantity. In addition, the velocity of the condensate in the pipe is probably slower near the trap than elsewhere, and this will allow a longer time for the reactions to continue.

As to possible remedies—the first would be to eliminate as far as possible any infiltration of air into the system by having all joints airtight. It may also be possible to reduce the quantity of soda ash used in the feed-water treatment, although of course not to the extent that there is a possibility of any additional scale being allowed to form in the boiler. Without

any knowledge of the plant, I would say that to remove the oxygen from the feedwater deaerators would not be economically justifiable, nor would it pay to provide electrically insulated joints to prevent the flow of stray electric currents.

Changing the pitch of the condensate line slightly to prevent any building up of the condensate near the trap may be found worth while. If this is done, care must be taken not to allow any other pockets to occur in the return line at other points. Changing the pitch of the return line will not prevent corrosion in any way, but it may prevent its concentration in any one place. This will help lengthen the time between replacements, although when replacements become necessary more will be required.

Boston, Mass. DAVID H. LITTLE.

Admit Soda Ash Ahead of Corrosion

CORROSION difficulties are encountered in a large number of plants all over the United States. The chief source of trouble is the presence of oxygen in the feed water. This is liberated in the boiler and passes out with the steam to the various auxiliaries in the plant. In the case of a heating system, the oxygen shows up in the return line.

Likewise the bicarbonates of calcium and magnesium in feed water break up in the boiler drum and liberate CO_2 gas, which passes out with the steam. The carbon dioxide finally appears in the condensate line in the form of carbonic acid, which reduces the hydrogen-ion value of the condensate to a low point. With acid water in the presence of oxygen there is rapid corrosion, depending upon acidity and the amount of oxygen present.

I suggest that you introduce your soda-ash treatment into the condensate line ahead of the noticeable corrosion, in order to neutralize the carbonic acid and raise the hydrogen-ion value of the condensate to 9 or better. Another alternative would be to install a deaerating heater to eliminate the oxygen in the boiler feed water. However, in the case of a vacuum system the infiltration of air soon contaminates the returning condensate, so this suggestion would only be of value on a pressure system.

Central heating plants have found that treating the feed water with lime and soda ash, external to the boiler, gives good results. The oxygen is reduced to a low value and the CO_2 is absorbed by the lime treatment. Return water is usually very close to neutral. Corrosion is cut to a minimum.

Size of plant, cost of repairs and local conditions should govern your selection of the proper equipment to overcome the corrosion mentioned.

Chicago, Ill. J. D. K.

Deaerate All Boiler Feed Water

INDICATIONS are that large concentrations of the corrosion-promoting gases, oxygen and carbon dioxide, are being carried into the heater with the steam. One would expect the region of most severe metal attack to be that in contact with the heater drip or surfaces in the lower portion of the heater shell. There both of the gases, being heavier than steam, tend to collect, finding escape only through dissolving in the condensate. The piping suffers most, either because it is of more vulnerable material than the shell or because of a relatively high velocity and probable drop in pressure through it.

Original deaeration of all boiler feedwater appears as a logical general attack on the problem. Oxygen, always present in raw water, is best removed before it reaches a part of the system subject to its action. A simple open feed-water heater of ample capacity, and thorough venting, might have a place in the system. A vent for non-condensible gases located just above the condensate surface in the water heater with which we are here concerned should bring about some relief. Discharge from the vent would require adjustment to an amount just sufficient to insure removal of the fixed gases without appreciable steam loss.

It appears that any use of soda ash in the boiler should be questioned. Breakdown of the carbonate could be the source of CO_2 responsible for the trouble. Liberation of carbon dioxide is serious even when the soda ash serves a good purpose. Use of this chemical is as often traditional as it is necessary or logical. Should the feedwater impurity be, for example, calcium carbonate or bicarbonate, the treatment could be accomplishing no good and might be contributing largely to the trouble.

Corvallis, Oregon. R. E. SUMMERS,
Oregon State College.

Opinions Vary on What Constitutes Good Electrical Insulation

ANSWERS to March Question 2

THE QUESTION

WHAT *is good insulation on electrical power-plant equipment? That is the question that is troubling me. If the A.I.E.E. Standard minimum insulation resistance is accepted, then, for medium- and large-size machines, the resistance may be less than 0.5 megohm, a value that I feel many engineers will consider too low. If we do not accept the A.I.E.E. Standard, then what rule are we to use for a guide as a safe value of insulation resistance? How frequently should insulation resistance tests be made? When the insulation resistance of a machine is low, what is the best way to go about bringing it back to a good value? What is the lowest-voltage machine on which it is safe to use a 500-volt megohm meter? Probably* POWER *readers can tell me how they handle these and other problems having to do with maintaining the insulation in a safe condition on electrical machinery.*—I. R. H.

Considers A.I.E.E. Rule a Safe One

I HAVE FOUND the A.I.E.E. standard rule safe to use for determining minimum value of electrical power equipment insulation resistance. This rule is:

$$\textit{Insulation Resistance (megohms)} = \frac{\textit{Machine Terminal Voltage}}{\textit{Kva. Rating} + 1{,}000}$$

However, the equipment should be clean and dry and at operating temperature before testing. I have always insisted that newly installed equipment, even if reconditioned, should have an insulation resistance of one megohm or better, regardless of the value obtained from the A.I.E.E. formula.

The frequency of making insulation-resistance tests is a matter each individual must decide for himself, inasmuch as operating conditions, location of equipment and atmospheric conditions affect the answer. A machine in a dry clean place need not be tested as frequently as one in a damp location.

My practice is to insist on a yearly check on all equipment. Equipments with an insulation resistance below the minimum value, or showing a decided change downward, are given a thorough cleaning and the more obvious causes, such as water from the roof, oil, dust, etc., looked for and removed. Equipment which is not corrected by cleaning and shows an insulation resistance below minimum value is thoroughly dried out. This is done by the most feasible method.

If after drying the insulation still tests below minimum value, assume a defect exists and make high-voltage test. The defective portion is thus located and repaired. For values of voltage to use when making high-voltage tests, refer to the A.I.E.E. rules.

It has been my practice to use a 500-volt megohm meter on equipment rated from one to 600 volts and a 1,000-volt megohm meter on equipment for voltages above 600 volts. These have given satisfactory results, and in no case was the equipment damaged.

West New York, N. J.
KERMITT HOFFMAN.

Favors High-Voltage Tests

WITH DUE RESPECT to the megohm meter, I would not depend on it for testing large high-voltage equipment. An experience I had while with a large southwestern power company may be cited. A large turbo-generator had been overhauled, the cable potheads repoured and other changes made. When the job was finished, the entire layout was tested with a megohm meter which three times indicated infinity. The machine was brought up to speed preparatory to phasing out. Voltage was built up to 11,500 when an insulator on the generator bus broke down and started an arc to ground. Yet these were supposed to be 15,000-volt insulators and had been tested. Had this machine been given an A.I.E.E. standard high-potential test, the bad insulator would have been found without running the risk of serious damage to the equipment.

When insulation resistance tests low, give the machine a good cleaning with an oxfiber brush and carbon tetrachloride and wipe clean with rags. Then dry it out thoroughly and give the windings a couple of coats of good insulating varnish. If possible dry this varnish at about 125 deg. F. or higher.

A 500-volt megohm meter can be used on any equipment designed for 110 volts and higher. The frequency at which insulation tests are made depends upon conditions under which the equipment must operate. In the average power plant in the east and middle west, a test every three months is sufficient. In parts of the country such as west Texas, New Mexico and Arizona, a test every 6 to 8 mo. is ample to assure safety.

Independence, Mo. J. W. DE CAMP.

Good Insulation Is Difficult to Determine

GOOD INSULATION is difficult to determine. A defective high-tension transformer bushing may measure infinity, while a good 4,000-volt cable may measure 10,000 ohms. Insulation resistance varies with the surface area exposed to the conductor. The insulation-resistance reading obtained from a short length of cable would be approximately in inverse ratio to its difference in length compared to that of a longer cable having the same quality of insulation.

In general an insulation resistance of one megohm is considered a fair lower limit for such apparatus as motors, generators, rotary converters, power cables and general wiring. There are exceptions, such as large machines and long cables, where readings lower than one megohm may be considered satisfactory. High-tension equipment that is not oil-immersed usually has much higher insulation resistance.

Actual operating experience is about the only guide for determining the safe value of insulation resistance. Local weather and operating conditions determine frequency of testing insulation resistance.

When insulation resistance is found to be low it can usually be increased by thorough cleaning, drying and varnishing of the winding. The lowest-voltage machine on which it is safe to use a 500-volt megohm meter is 110 volts.

Fayetteville, N. C. G. E. PICKETT.

Gives Rules for Safe Values of Insulator Resistance

REGULATIONS for insulation resistance by the A.I.E.E. and also the Underwriters Laboratories indicate what may be called "safe rules for minimum values of insulation resistance." Usually in practice readings much higher than the minimum recommended values are found for both new and old electrical equipment. It is usual practice to exceed these values, not only at installation but as long as the equipment is in service.

Many megohm-meter users have established their own standards for insulation resistance. One electrical manufacturing company requires for all machines a minimum insulation resistance in megohms equal to three times normal terminal voltage divided by rated capacity in kva. Many engineers use the simple and more or less arbitrary rule that insulation resistance should be not less than one megohm per 1,000 volts rating of the apparatus.

From a study of the practices of a large number of megohm-meter users, it has been found that in general an insulation resistance of one megohm is considered a fair allowable lower limit for the ordinary run of electrical apparatus. There are exceptions of course, where a lower resistance than one megohm may be considered satisfactory, such as for large machines and long cables. With one megohm insulation resistance, it is reasonably certain that there are no serious surface leaks and that the power apparatus is reasonably dry.

Perhaps the greatest advantage of megohm-meter testing is in keeping and comparing records of tests made on each piece of equipment. All tests should be taken with the equipment disconnected from the line and preferably near operating temperature. Insulation resistance decreases rapidly with an increase in temperature.

Waynesboro, Va. J. M. MYERS.

THE ENGINEER'S BOOKSHELF

Combustion

COMBUSTION (INDUSTRIAL GAS SERIES) THIRD EDITION (1933). *By George Segeler, industrial engineer. Published by American Gas Association, 420 Lexington Ave., New York, N. Y. Paper Cover; rounded corners, 208 pages, 9x12 in., 201 tables, 197 charts. Price $2.*

This third edition, while carrying the old name is, in fact, a complete new book. The quality of its contents fully justifies the enthusiastic reception it is receiving in the field, as exemplified by its wide adoption as a text in engineering schools. It should be of great value to all engineers interested in the practical and theoretical phases of combustion and contains a large amount of material not easily unearthed elsewhere. The book is divided roughly into two parts, theoretical and practical. Advanced theory is introduced in the chapters on the chemistry of combustion, heat transfer and the design of atmospheric burners. An entire chapter is devoted to workable formulas for calculating heat transfer under various conditions. The chapter on combustion data of commercial gases covers a fairly wide range of gases and is based on the actual gas served to the customer.

It is felt that the combustion material here presented, while prepared with only gas combustion in mind, will be of great value as well to engineers burning coal or oil.

Pumps and Turbines

CENTRIFUGAL PUMPS, TURBINES AND PROPELLERS (1934). *By Wilhelm Spannhake, professor of hydraulic engineering, Technische Hochschule, Karlsruhe, Germany. Translated into English by John B. Drisko. Published in Germany by Julius Springer, Berlin, and in the United States by the Technology Press, Massachusetts Institute of Technology, Cambridge, Mass. 328 pages, 6½x9½ in. 182 illustrations. Price $5.*

Those who had opportunity to become acquainted with Prof. Spannhake and his work when he was Visiting Professor of Hydraulics at the Massachusetts Institute of Technology will welcome this opportunity to have in concrete form, at least in part, his thinking on hydraulic engineering. In this text, the basic theory and characteristics of centrifugal pumps, hydraulic turbines, and propellers are presented. Its primary functions are to enable the reader to understand the operation and operating characteristics of existing machines by a presentation of fundamentals and to instruct in the design of such machines.

The work is divided into four parts:

Part A, "Essentials of Hydromechanics," wherein effort has been made to present more clearly certain ideas that are often not apparent to engineers and to formulate them mathematically after appropriate physical examination. Part B, "The Full-Admission Turbo-Runner in Enclosed Flow," deals with the mean stream-filament theory. Equations are given based on this theory by which operating characteristics of pumps and turbines can be predicted, giving results in close agreement with observed results. Part C, "Full-Admission Turbo-Runners in Unenclosed Flow," presents a jet theory in whch the rotating components in the jet are taken into account to predict blade angle, output and efficiency. Part D, "The Modern Impulse Turbine," treats this subject in much the same way as other books on design. The treatment limits the use of the book to designing hydraulic-machinery engineers and advanced engineering students. To this class of readers it will be an outstanding contribution to engineering literature.

Engine Indicator

THE ENGINE INDICATOR—ITS DESIGN, THEORY AND SPECIAL APPLICATIONS (1934). *By K. J. DeJuhasz, assistant professor of engineering research, Pennsylvania State College. Published by Instruments Publishing Co., 330 West 42nd St., New York, N. Y. 240 pages, 5½x8½ in. Indexed. 132 figures, containing 300 separate illustrations. Price $3.75, including a 1-yr. subscription to "Instruments" magazine.*

At last a modernized treatment of the engine indicator—not only the older steam-engine indicators but all the more modern types as well. Of interest to engineers in power plants, pumping stations, engine factories, research laboratories and for others who investigate forces, motions and variable pressures (whether in an engine or not). DeJuhasz developed the indicator bearing his name, took part in development of several others, and more recently has been engaged in finding new uses of "normal" indicators in special locations. Everything from data on ammonia compressors and their slow pressure variations to the extremely short and high pressures of firearms is included.

Treatment is uniformly readable and the illustrations are large enough and clearly enough drawn to lend considerable assistance to the reader.

Engineering Career

BUILDING AN ENGINEERING CAREER (1934). *By Clement C. Williams, dean, College of Engineering, State University of Iowa. Published by the McGraw-Hill Book Company, Inc., 330 West 42nd St., New York, N. Y. 247 pages, 5½x8 in. 51 illustrations. Indexed. Cloth. Price $2.*

Planned to provide the engineering college freshman with the vocabulary and mode of thinking of engineers, this text bases its instruction on the history of engineering development. It endeavors to sustain the reader's interest by picturing the romance and drama of engineering achievements. It is clear and straightforward and contains a number of interesting drawings and graphs picturing milestones of development in various fields, changes in salaries and work of engineers at given times after graduation, development of various specialized types of engineers, development of engineering itself, etc. It is principally of value to the young man selecting or beginning an engineering career.

BRIEF REVIEWS

FLAME TEMPERATURES IN AN INTERNAL-COMBUSTION ENGINE MEASURED BY SPECTRAL LINE REVERSAL. *By Albert E. Hershey and Robert F. Paton. Bulletin No. 262, Engineering Experiment Station, University of Illinois.*—A study of the burning of fuel in the cylinder to determine the instantaneous values of the pressure, volume, temperature gas concentrations. Spectral-line reversal was used to measure instantaneous flame temperatures. Address Engineering Experiment Station, Urbana, Ill.

CAUSE AND PREVENTION OF CALCIUM SULPHATE SCALE IN STEAM BOILERS. *By Frederick G. Straub. Bulletin No. 261, issued by the Engineering Experiment Station, University of Illinois, Urbana, Ill.*—Data with regard to solubility of calcium salts alone, and in the presence of positive and negative ions over the entire pressure range of boiler operation, as well as data with regard to the behavior of these chemicals under conditions simulating those of actual operation. Address Engineering Experiment Station, Urbana, Ill.

OUTLINE OF THE MANUFACTURE AND PROPERTIES OF POWER-PRESSED BRICK. *By A. C. Hughes, Harbison-Walker Refractories Co., Clearfield, Pa. Technical Bulletin No. 44, dated November, 1933, of the American Refractories Institute, Pittsburgh, Pa.*—Information on power-pressed method of forming refractory brick, with a table of properties.

GROUND-WATER RESOURCES. *Issued by the United States Geological Survey, Department of the Interior. Two investigations.*—One a report of underground-water supply available for Houston, Texas, and vicinity, which has been in progress for the last three years. The other a preliminary report of the Walla Walla Basin, Oregon-Washington.

NRA CODES. *Published by the Government Printing Office, Washington, D. C. 3 vol. Price $1.50 per vol.*—Listing of approved codes in chronological order. The first volume from July 9, 1933, to October 11, 1933; the second Oct. 12 to Nov. 10; the third Nov. 11 to Dec. 7.

WHAT'S NEW IN PLANT EQUIPMENT

Liquid-Gas Mixer

Complete mixing of gas and liquid, or gas washing, gas cooling, oxidation, steam desuperheating, etc., can be secured with liquid-gas contactor. As illustrated, water and gas are forced into contact. Any desired ratio of liquid to gas can be maintained. Heavy fluids or slurries may be contacted with a gas or vapor.

Blaw-Knox Co., Pittsburgh, Pa.

Tube-End Polisher

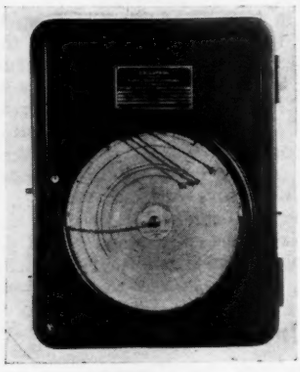
For polishing exteriors of boiler tubes before rolling in. Rotary, pneumatic, heavy-duty unit with pilots bearing on tube exterior. Entirely automatic, not subject to variations from flat spots. Ends may be polished in stacks without moving tubes.

Chicago Pneumatic Tool Co., 6 East 44th St., New York, N. Y.

Blowers with Variable-Speed Drives

Where variations in volume are required, blowers, vacuum pumps and gas pumps connected through variable-speed drive to a constant-speed motor now supplied. Especially applicable where seasonal peaks or processing makes variations necessary. Variable-speed drives also used with heavy-duty cycloidal rotary pumps for handling viscous liquids, or for producing vacuums up to 26-in. Hg. for handling vapor and liquid together.

Roots - Connersville Blower Corp., Connersville, Ind.



Potentiometer Pyrometer

Galvatron potentiometer-pyrometers employ galvanometer-electronic relay circuit to operate slide-wire resistances and recording pens. Timing contacts, recording chart and automatic standardizing relay contacts driven by synchronous motor. Continuous records, up to four, can be made on circular recording chart.

Bailey Meter Co., 1050 Ivanhoe Rd., Cleveland, Ohio.

Insulation Block

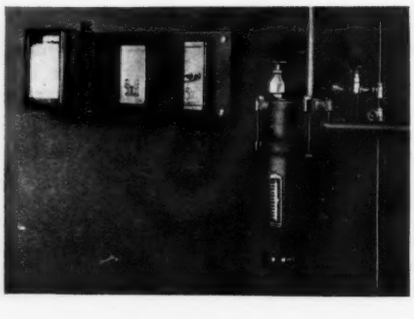
"Superex" insulation block will withstand temperatures up to 1,900 deg. F. Made of special calcined diatomaceous silica and bonded with asbestos fibre, it has a low density and high insulating value.

Johns-Manville, 22 East 40th St., New York, N. Y.

Concentration Meters for Boilers

To help control concentration of salts in boilers and protect turbine blading, a boiler salt concentration recorder has been developed. Consists of two units, pressure-reducing chamber with adjustable-inlet needle valve, electrode and indicating thermometer, and recorder. Furnished in either portable, wall, front or flush cases.

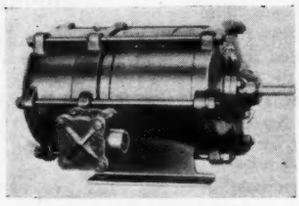
Esterline-Angus Co., Indianapolis, Ind.



Protection for Metal Surfaces

S. R. P. metal-protective coatings check erosion and corrosion of metal surfaces exposed to sulphuric acid, strong alkalies, salt water, etc. Test panels and samples on request.

L. Sonneborn Sons, Inc., 88 Lexington Ave., New York, N. Y.



Capacitor Motors

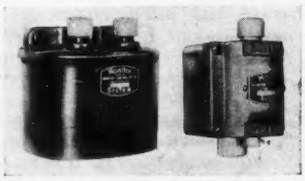
Especially suitable for all Class I, Group D hazardous locations, these single-phase, explosion-proof, self-contained capacitor motors can be connected to either 110 or 220 volts. Simple, positive-action switch cuts out capacitor at definite, predetermined speed. Capacitor built in. Non-ventilated type, ½ to 1 hp.; enclosed, fan-cooled 1½ to 3 hp.

Louis Allis Co., Milwaukee, Wis.

Valve Reseater

"Jiffy" reseaters resurface flat globe valve seats while connected in line. Cutting head of tool steel with cutters hollow ground. Spring provides pressure for cutting blades. Automatically centered.

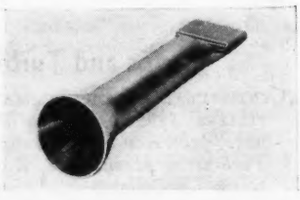
Hutton & Jenks, Bancroft, Ia.



Push-Button Stations

Type 9000M (at left) oil-immersed push-button stations for use in corrosive or damp atmospheres. Switch assembly mounted on cover, which includes mounting screw holes and tapped conduit entrance. Type 9000V (right) is heavy-duty weather-proof control station. Quick accessibility to stop button, with start button in protected place. Fixed contact plate can be adjusted to conform to position of conduit entrance, which entrance may be turned to top, bottom or either side. Available in single-, 2-, or 3-button types and variety of contact arrangements.

Monitor Controller Co., 75 West St., New York, N. Y.



Condenser Tubes

Anaconda Extruded Condenser tube is also rolled and drawn. Produced by extruding cast billets which have been machined to remove surface irregularities, then cold swaged-rolled and cold drawn. Available in standard and special alloys.

American Brass Co., 25 Broadway, New York, N. Y.

Centrifugal Pump

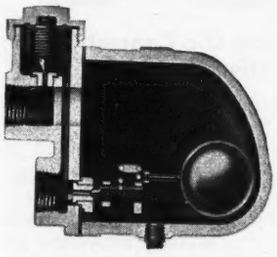
Designed particularly for refinery service, thus have heavy parts, casings capable of withstanding hydraulic pressures much over actual working pressure, and no stuffing box leakage. Extra deep water-jacketed stuffing boxes have pressure breakdown and bleed-off connections, grease sealing glands and large packing space. Steel split smothering glands smother with a stream of water any leakage which might get past

stuffing box packing. Are bronze bushed to prevent sparking. Large-diameter shafts have low rotative speed. Stages arranged so that even in high-head units, pressure on any stuffing box is not more than one stage above suction pressure. Over-size, water-cooled, grease-lubricated ball bearings are operated at almost no load, because of hydraulically balanced rotor.

Worthington Pump & Machry. Corp., Harrison, N. J.

Combination Trap

Type FTO-H, combination float-thermostatic steam trap now available for pressures to 180 lb. per sq.in. Compact and



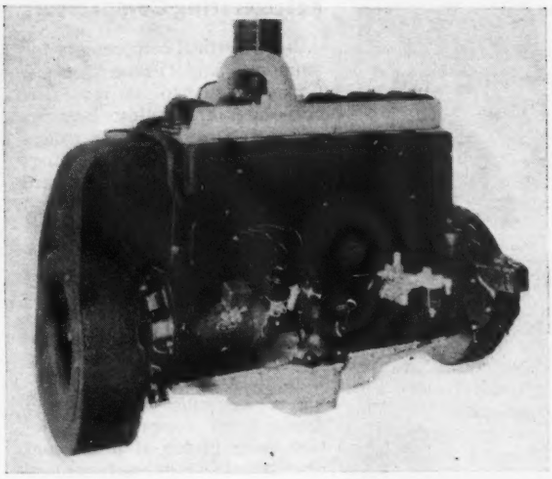
light, it can be supported directly on piping. All working parts are on cover and easily cleaned. Main discharge valve and seat stainless steel.

Sarco Co., 183 Madison Ave., New York, N. Y.

Fireproof Control Cable for Elevators

Electric operation of elevators depends upon flexible insulated cables connected between cars and terminal boards in hoistways. Therefore, reliability of this cable is a large factor in quality of service. In this control cable, fireproof qualities are obtained by specially treated fireproof sheath. To avoid possibility of fire burning along outside of cable, outer covering consists of a specially treated fibrous, fire-resistant and moisture-proof sheath. Conductors made up of fine copper strands insulated with 30 per cent rubber compound, rubber insulation and protective fireproof covering having been made very flexible. Bulletin.

A. B. See Elevator Co., Inc., 419 Fourth Ave., New York, N. Y.



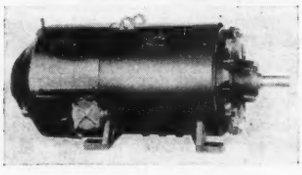
Air-Cooled Engines

Adapted for stationary power for driving air compressors, motor generator sets, etc. Model 6A-400 has 4⅛-in. bore and 5-in. stroke, developing 111 hp. at 2,600 r.p.m. Models 6AH-309, 6AH-377 and 6AH-400, horizontal air-cooled engines develop 85, 104 and 111 hp. respectively.

Doman-Marks Engine Co., Amesbury, Mass.

D.C. Motor

Direct-current, fan-cooled, explosion-proof motors. Illus-

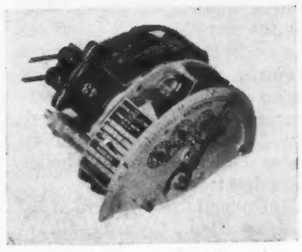


trated is a 25-hp. motor running at 806 r.p.m. Quick and easy inspection of commutator and brushes by three screw caps.

Louis Allis Co., Milwaukee, Wis.

Demand-Meter Registers

This register can be applied to eight different types of G-E watt-hour meters. New testing device, adapted for manual operation, permits an over-all "accuracy" check of the register in about one minute. Follow-up principle used in resetting mechanism. Full torque of



motor available automatically if needed to insure positive reset. Interval indicator shows how much time has elapsed and how much remains.

General Electric Co., Schenectady, N. Y.

Star Drills

Made of high-carbon chisel steel, drop forged, hardened and tempered. Shanks of proper stiffness to prevent bending. 8-, 12-, 18- and 24-in. lengths are made in diameters from ¼ in. to 1 in., by sixteenths, 1-in. to 1½-in. diameters come by eighths in 12-, 18- and 24-in. lengths.

Armstrong Bros. Tool Co., 317 N. Francisco Ave., Chicago, Ill.

Vacuum Contact Relay

Type HBA, intended for use in atmospheres which may contain explosive gases, is a vaccum contact auxiliary potential relay. Will close and interrupt a 5½-amp., 250-volt d.-c. circuit ten-million times without maintenance. Equipment is inclosed in steel container, and has single-pole, double-throw contacts in heavy-walled glass tube, from which air is evacuated. Ratings are 15 amp. continuous, 10-amp. interrupting at 115 and 230 volts, 60 cycles and 125 and 250 volts d.c.

General Electric Co., Schenectady, N. Y.

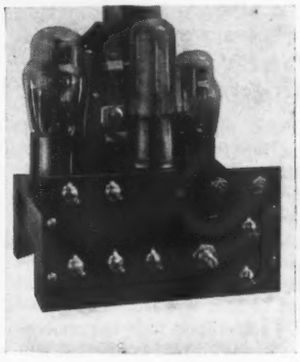
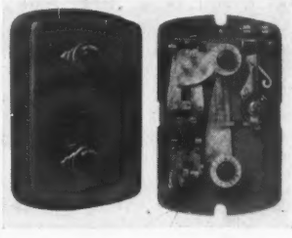


Photo-Electric Relay

Heavy-duty contactor in "LE" relay interrupts 20-amp., 115-volt, A.C. non-inductive load or 3-amp., 115-volt D.C. In applications such as counting, operating speed is extremely fast, ranging from 200 to 600 objects per minute. Telephone relays have been eliminated.

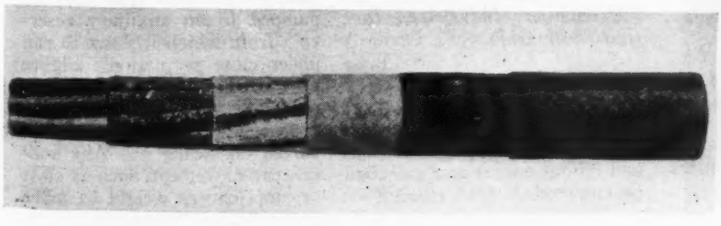
Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

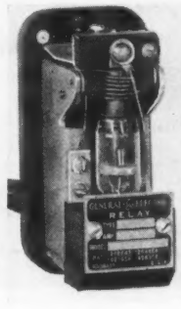


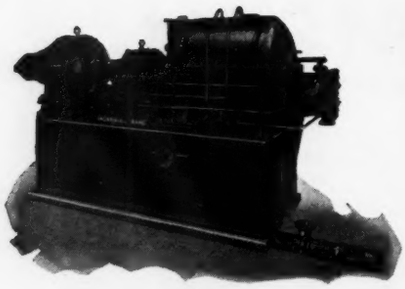
Temperature Controller

"Comfortrol," or effective temperature controller, gives complete control of heating, cooling, humidifying and dehumidifying or any two or three of these four functions. Replaces thermostat and humidistat consists of temperature-sensitive element and relative-humidity-sensitive element with complementary electric-contact mechanism and setting pointers so interlinked that it is possible to vary ratio of these two factors while leaving effective temperature condition unchanged, and also varying effective temture as desired. Multiple human-hair humidity element, bimetallic temperature element. Range in relative humidity from 10 to 90 per cent, effective temperature from 62 to 77 deg.

Julien P. Friez & Sons, Inc., Baltimore, Md.







Water-Vapor Refrigeration

Two units, steam-jet and centrifugal water-vapor refrigeration applicable wherever cold water is wanted for industrial processes, air-conditioning, etc. Steam-jet unit operates on steam at any pressure above atmospheric. Standard ratings from 15 tons upward. Centrifugal water-vapor unit has motor or turbine direct-connected to multi-stage centrifugal compressor, both mounted directly above evaporator. This unit automatically reduces power consumption at partial loads when operating at constant speed. Standard sizes from 50 to 300 tons refrigeration. Bulletin.

Ingersoll-Rand Co., 11 Broadway, New York, N. Y.

Special Insulation

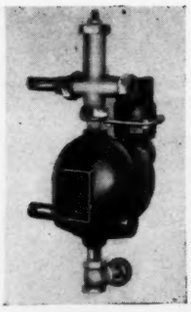
"Metallation" is sheet aluminum cemented to both sides of heavy tough kraft paper. Both edges scored 1½ in. from edge for bending for application between building framing members. In rolls, 17 or 32 in. wide, and with aluminum on one side only in rolls 32 in. wide. Will not tarnish or corrode and reflects about 95% of heat striking it. Also water-, wind- and odorproof. Also usable corrugated for pipe insulation with canvas covering and spacers to hold it off pipe.

Reynolds Metals Co., 19 Rector St., New York, N. Y.

Hard-Surfacing Electrode

Deposits made with "Wearweld," a shielded-arc electrode for building up steel surfaces to resist shock and abrasion, are air-hardening alloy steel. Can be used to build up all steels other than those of austenitic type, or for facing parts subjected to rolling or sliding abrasion, batters and abrasion and repeated impact. Good deposits in very thin layers. If shaping is necessary, deposit may be ground to size. Two sizes—¼ and $\frac{5}{32}$-in. diam.—in 18-in. lengths. Packed in 50-lb. steel containers.

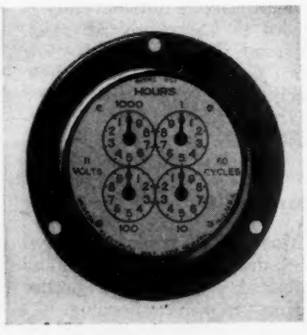
Lincoln Electric Co., 13034 Coit Road, Cleveland, Ohio.



Low-Water Cut-Off

No. 60, especially recommended for round boilers with max. steam pressure 25 lb. This method of hook-up assures gage-glass conditions in cut-off body under all steam pressures, also reduces installation time. For 110-220 volt circuit. Cut-off inside boiler; all linkage outside. Requires no pipe cutting, and special new type handles pressures to 100 lb. max. if desired. Can be combined with safety feeder for automatic boiler water-level control.

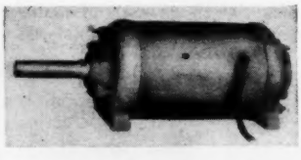
McDonnell & Miller, 1310 Wrigley Bldg., Chicago, Ill.



Hour Counter

Consists of special ball-bearing, self-starting synchronous motor, drawing less than 2 watts, connected through cut gears to an indicating train on face of instrument. Panel type Bakelite case, with flange diameter 3½-in. Regularly furnished for 110-volt, 60-cycle circuits. Also in other voltages and frequencies. Bulletin.

Weston Electrical Inst. Corp., Waverly Park, Newark, N. J.



Arbor Motor

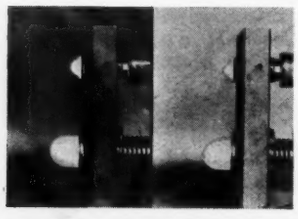
Sizes from 2-10 hp. Especially adaptable where mounting space is limited. Self-ventilated type. Bulletin.

Louis Allis Co., Milwaukee, Wis.

Refrigerating Compressors

2-cyl. vertical compressors for ammonia and Freon service. Capacities one to 100 tons. Incorporates frictionless bearings where applicable, tapered rollers being used for main bearings and straight roller for outboard bearings. Pressure lubrication furnished in connecting-rod bearings in larger units through rifle-drilled shaft and connecting rods. Oil passing through rotary disk filter on discharge side of positive gear pump. Gear pump simple in construction and capable of discharging oil, regardless of rotational direction of compresor. Suction valve in top of piston and discharge valve in easily removable safety head, thus providing maximum valve areas. Main stop valves, pump-out, safety valves and starting by-pass incorporated in self-contained manifold. Drive either direct by synchronous motor, or through multi-V-drive to motor. Bulletin.

Worthington Pump & Machinery Corp., Harrison, N. J.



Indicating Lamp

Can be used for signal-light indication or in combination with control switches to tell whether a circuit breaker is open, closed or tripped automatically. Indicating unit consists of resistor of vitreous-enamel type, receptacle and escutcheon of insulating material (permitting their use on metal panels) 24-volt lamp and color cap (which may be clear, red, yellow or green). Illustration shows old and new style with new type above.

General Electric Co., Schenectady, N. Y.

Aluminum Paint

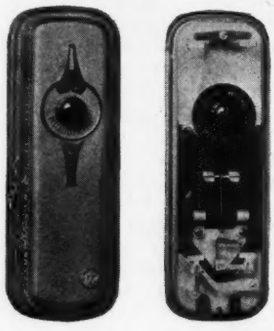
Using a vacuum process to explode powder lumps which form during processing of aluminum paint, produces an easy spreading paint of uniform brilliance and full protection. Bulletin.

Aluminum Industries, Inc., Cincinnati, Ohio.

Packing Ring

Designed for severe service at natural-gas pumping stations and on gas-engine and gas-compressor rods. Also efficient on steam-engine rods using superheated steam. Each ring individually cast of specially dense iron, five rings being standard installation. Interchangeable. Through use of a hoop spring, tension more even and constant. Any diameter.

American Metallic Packing Co., Pittsburgh, Pa.



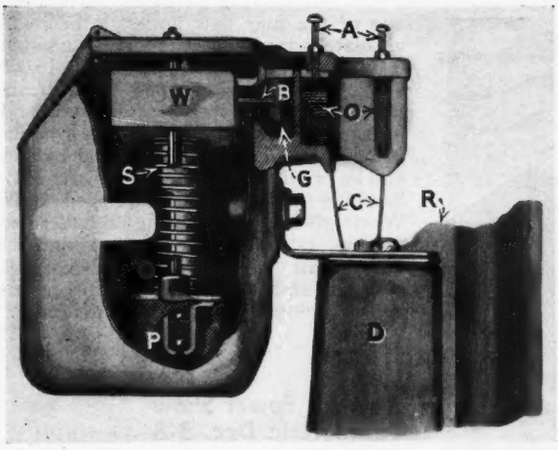
Automatic Control for Relative Humidity

"Humidistat" Types H/4 to 7 for automatic control of relative humidity in all classes of comfort and industrial applications. Handles solenoid or motor-operated valves, damper motors, etc., without relays and at either low or line voltage. Can be used on any humidifying and dehumidifying air-conditioning unit. Element is multiple human hair, unaffected by temperatures up to 175 deg. F., accurate to within 1% differential, adjustable to anything greater desired. Range 10 to 100% R.H. New knob and rotating dial for setting do not require charts or psychrometers. Aluminum case with special finish proof against corrosion. Also, in same design, are thermostats for automatic temperature control anywhere, with or without relays. Range 55 to 85 deg. F., to differential of 1 deg. F. Silver contacts. Also relay-transformer sets and control assemblies for use in conjunction with these instruments. Bulletin K.

Julien P. Friez & Sons, Inc., Baltimore St. & Central Ave., Baltimore, Md.

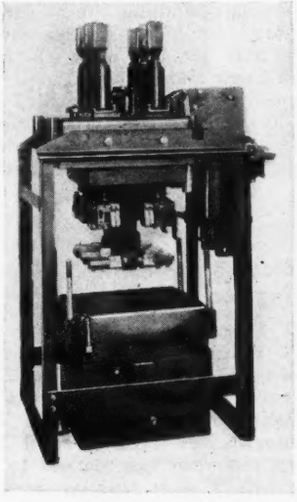
Guide-Rail Lubrication of Impulse Type

As elevator-car speeds increase, adequate, efficient guide-rail lubrication has become more difficult. Various automatic lubricators have been tried, some using grease and others oil. This type uses oil pumped to an auxiliary reservoir from which it flows to rail under close regulation. Figure shows section through lubricator. *P* is an inertia-type pump operated by weight *W*, supported on spring *S*. Any sudden car movement, such as start or stop, causes weight to move



up and down and operate pump: Oil is delivered through pipe *B*, into groove *G* leading to three chamber openings *O*, one for each wearing surface of guide shoe. Each chamber *O* is filled with cut felt to absorb and retain oil. Wire conductors *C* at bottom of each chamber carry oil out and deliver it in drops to a groove adjacent to rail *R* around top of guide shoe *D*. Oil flow to rail is regulated by changing compression on retarding felts with adjusting screws *A*. Any surplus oil delivered to groove *G* is returned to reservoir through an overflow. Quantity of oil pumped can also be regulated by adjusting pump stroke. Each lubricator has a capacity of 3 pt., sufficient to last several weeks with regulated flow of one drop per guide face per round trip for moderate high-rise, high-speed cars.

A. B. See Elevator Co., Inc., 419 Fourth Ave., New York, N. Y.



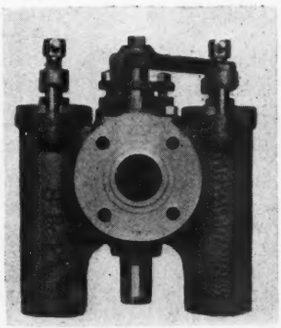
Oil Circuit Breaker

Type FK-44B-Y1 oil-blast circuit breaker is recommended for starting and jogging service or for severe-duty applications requiring apparatus to withstand frequent operation. Ratings are 15,000 volts at either 600 or 1,200 amp., 1-sec. short-time inrush rating of 60,000 amp., 5-sec. short-time inrush rating of 50,000 amp., and an interrupting rating of 100,000 kva. Tests show equipment will perform 10,000 operating cycles on 1,200 amp. at 2,300 volts without maintenance, contact reconditioning or oil change. Breaker of single-tank construction.

General Electric Co., Schenectady, N. Y.

Duplex Strainer

S&P duplex strainers have double valve plug inserted from top and retained against floating by steel shaft carrying adjustable thrust washer and jam nuts. Plug-shank packing is from top, and quick-removal or bolted well covers provided, depending upon pressures. Single or double baskets for each well, with perforations for fuel, lubricating or diesel oils. Ratio of



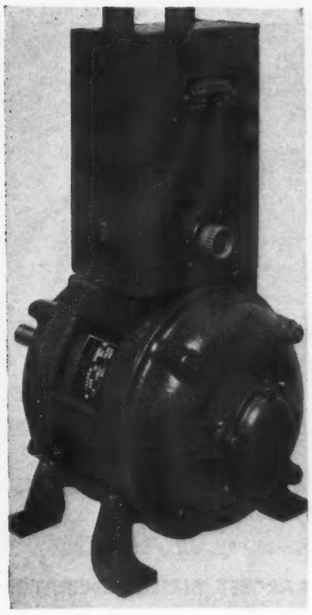
free-straining area through perforations is 4½ times nominal pipe cross-section with single baskets, 8½ times with double baskets. Strainer semi-steel, bronze or cast steel for working pressures up to 350 lb.

Staples & Pfeiffer, Ltd., 528 Bryant St., San Francisco, Calif.

Induction Motor

A self-protected motor has a protective device built into windings. Should motor stall through overloading, or become excessively hot due to poor ventilation or run on single-phase, the protector shuts off current. A.C. induction self-protected motors are built in sizes from ½ to 30 hp., for either 2- or 3-phase and standard commercial cycles and voltages.

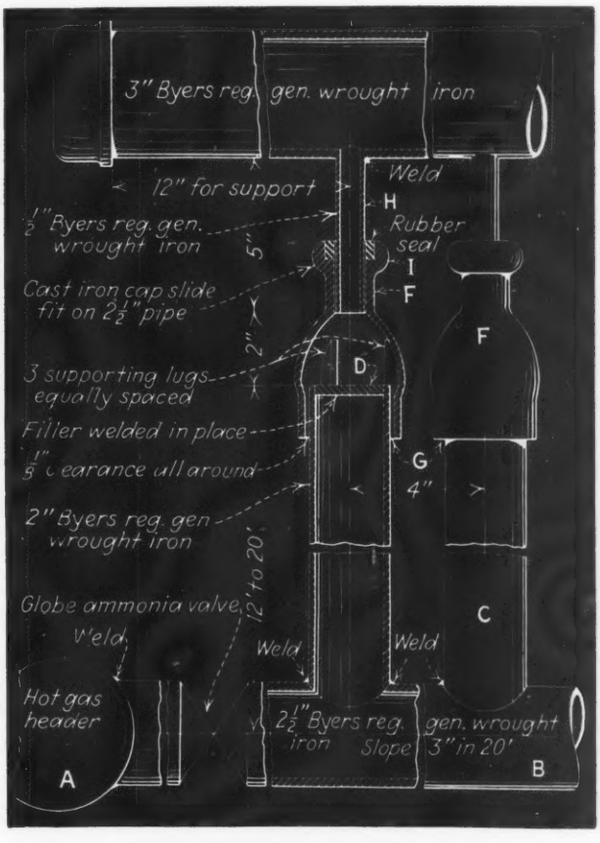
Lincoln Electric Co., 13034 tady, N. Y.

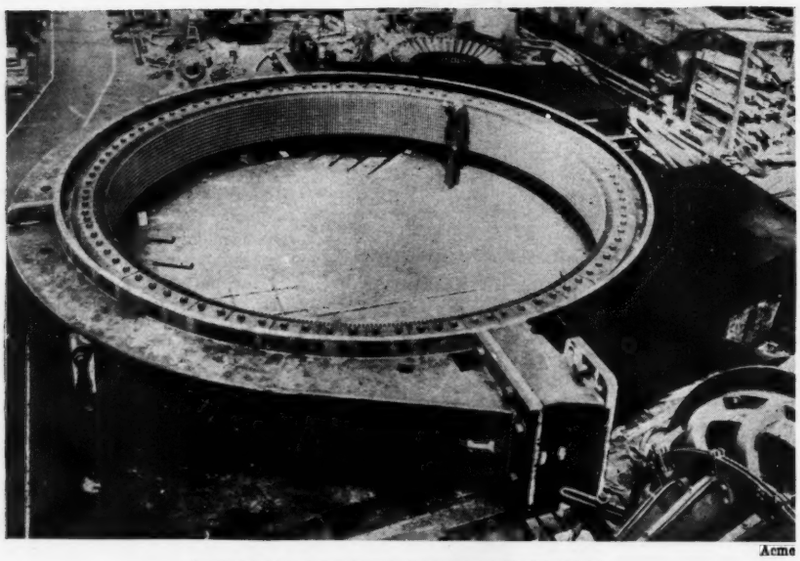


Vertical Atmospheric Condenser

This vertical condenser consists of combined gas and liquid header *A* and *B*, hot gas entering at *A* and condensate leaving at *B*. To this header are welded vertical pipes *C* with their upper ends blinded by plate *D*. Water from header *E* passes down into control nozzle *F* which has an annular space *G* that lays water on outer surface of pipe *C*. Nozzle *F* has centering lugs cast inside and is a slip fit over pipe *H* with rubber gasket at *I* for purpose of removing nozzle for cleaning or otherwise maintaining pipe. Condenser pan space required for a condenser of this type is approximately ¼ that required for horizontal atmospheric condenser of same capacity. In replacement, old pan, valves and headers can be used. Complete water coverage increases efficiency of circulating pumps, minimizes corrosion. Anchoring of vertical pipes at one end only avoids trouble from unequal expansion. High heat transfer and clean surfaces result from direction in which both water and formed condensate flow. All pipe surfaces subject to corrosion are of wrought iron, accessible at all times. About 93 per cent of total weight of this vertical pipe condenser is in actual condensing surface. Length of vertical pipes may vary between 8 and 40 ft., depending upon headroom available. Licensing by the patentee:

H. C. Guild, 1608 Clark Bldg., Pittsburgh, Pa.





Acme

WORLD'S LARGEST DIESEL GENERATOR

For Copenhagen's municipal power station, this welded stator is for a 19,000-kw., 3-phase, generator to be driven by the world's largest diesel, a 22,500-hp. unit. The workman is reading for winding at the Västeras plant of Swedish General Electric Co.

POWER LINES

Industrial Boiler Orders Show Great Increase

That industry is beginning to give serious consideration to its steam and power facilities to meet the demands of increased production and to replace obsolete equipment with modern units of efficient design is shown by the large number of inquiries being received and the contfacts that have been placed. Among some of the more important contracts recently placed with Combustion Engineering Co. for steam-generating equipment indicative of this trend, are the following:

Du Pont Rayon Co., Old Hickory, Tenn. — Two 12,500-sq.ft., 586-lb. pressure, sectional-header boilers with water walls, interdeck superheaters, air preheaters and tangential type pulverized-coal burners.

Firestone Tire & Rubber Co., Akron, Ohio—One 300,000-lb. per hr., 1,400-lb. pressure sectional-header boiler with water-cooled walls, slagging furnace, economizer, air heater and pulverized-coal burners.

Pennsylvania Salt Co., Wyandotte, Mich.—One 14,200-sq.ft., 450-lb. boiler with water walls, superheater, air preheater and complete furnace for burning pulverized coal.

Colgate-Palmolive-Peet Co., Jeffersonville, Ind.—One 4,100-sq.ft. 425-lb. bent-tube boiler with water walls and forced-draft, chain-grate stoker and economizer.

Wright Field—Two 5,350-sq.ft. bent-tube boilers with water walls and pulverized-coal burning equipment.

St. Joseph Ry. Lt. Water & Pr. Co., St. Joseph, Mo.—Two 7,960-sq.ft. sectional-header boilers with superheaters designed for 240-lb. pressure.

In addition to the foregoing, orders have been placed for a considerable number of smaller boiler units among industrial plants and a large number of stokers, indicative of the attention being paid to more efficient burning of fuel.

Westinghouse Starts New Boiler House at E. Pittsburgh

S. H. Merrick, president of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has just approved the following release: "The Westinghouse Company, realizing the timeliness of proceeding with rehabilitation work while the upturn of business is in evidence and feeling that such procedure will add weight to the general recovery and increase employment, has commenced construction of a new boiler house for plant process and heating purposes at the East Pittsburgh works. An interesting feature will be the modern entirely arc-welded construction of the new building to house the boiler, which will be erected on the site of one of the present boiler plants.

"Present plans provide for erection of a building having five of an ultimate of eleven bays and the installation of one boiler at a total cost of about $400,000. This first installation, which replaces six boilers of the present plant, is one of the four new boilers which will ultimately replace the 24 units now in use. The new boiler, rated at 16,000 sq.ft., will produce 150,000 lb. of steam per hr., and is capable of operation at pressures up to 600 lb. Each new boiler installed will have a 450-ton coal bunker and be provided with full-automatic coal-handling equipment. Equipped with Westinghouse link-grate underfeed stokers, ash evacuators, forced- and induced-draft fans, combustion control, and unit stacks, the boilers will provide unusually high efficiencies for the plant."

Eleventh Power Show To Be Held Dec. 3-8

The Eleventh National Exposition of Power and Mechanical Engineering will be held this year. The last Exposition was held in 1932. Grand Central Palace will again be the location, and dates selected are Dec. 3 to 8, during the week that the American Society of Mechanical Engineers holds its annual meeting in New York. Responsive to the new trends in expositions, the Eleventh National Exposition of Power and Mechanical Engineering will feature dynamic and graphic display. He who runs may not only read, but may learn through seeing mechanisms in operation. Thus certain technical advantages can best be demonstrated.

Power generation and distribution, engines and auxiliaries, electrical equipment and elevators, boilers, pumps, air compressors, refrigeration equipment—exhibits are being planned to show newest improvements. Exhibitors have more in mind the viewpoint of engineers who attend the Exposition, critically evaluating process design, to decide upon equipment specifications. In addition to power generation and mechanical engineering machinery, there will be innumerable auxiliary subjects, including piping and valves, instruments of precision, materials-handling machinery, fire-protection equipment, metals and metallurgy, and ceramic materials including fire brick and cements.

The Exposition will be managed as in the past by International Exposition Co., New York, and will again be under personal direction of Charles F. Roth.

Jacobus Elected President Of Welding Society

Dr. D. S. Jacobus, advisory engineer of Babcock & Wilcox Company and past president of the American Society of Mechanical Engineers, was elected president of the American Welding Society at its annual meeting in New York on April 26. The meeting this year was confined to a single day, with a short business session and committee meetings; technical sessions were eliminated. Other officers elected were: J. J. Crowe, Senior Vice-President; divisional vice-presidents; New York and New England, A. G. Leake; Middle-Eastern Division, W. W. Reddie, Middle-Western Division, E. L. Eksergian; five directors: A. M. Candy, J. H. Deppeler, A. E. Gaynor, O. E. Hovey, L. S. Moisseiff.

Semi-Annual Meeting of A.S.M.E. at Denver

The semi-annual meeting of the A.S.M.E. will be held in Denver, Colo., June 25 to 28, with headquarters at the Cosmopolitan Hotel. Some of the topics which will be discussed are: smoke problems, heat engineering, air conditioning and experiences in the burning of pulverized lignite, and petroleum coke.

A number of interesting inspection trips have also been planned for the meeting.

Free Electricity

In deciding what to do with the 20,000,000 kw.-hr. of surplus hydro-electric energy which will be generated this year in Northern Wisconsin and Upper Michigan by unusually heavy snowfalls, Milwaukee Electric Co. will offer free electricity to its customers during April and May. Customers will be allowed to use as much electricity as they desire, the bill to be no larger than the March invoice.

Combined Heating and Refrigerating Plant

The first combined commercial heating and refrigerating plant using anthracite coal has started operation in a large warehouse for the storage of meats and provisions in Pottsville, Pa. The plant was designed and built by Philadelphia & Reading Coal & Iron Co., under direction of John G. Reid, manager of the Pottsville shop.

The equipment consists of an absorption refrigerating machine utilizing steam generated by the new furnace. The large meat storage rooms, with a capacity of four or five carloads of meat, will be air-conditioned by the refrigeration plant operating a cold diffuser. Circulation is maintained by a small pump operated by a ⅓-hp. motor. Provision has been made for heating the building in the winter and supplying hot water to the establishment.

Machinery Meeting at Cleveland, May 14-15

The Machinery and Allied Products Institute will hold a two-day meeting in Cleveland, Ohio, May 14-15. Headquarters will be the Hotel Cleveland. A permanent code authority for the machinery and allied products industry will be elected at this meeting. Trade stimulation and other topics will also be discussed.

Diesels Popular In Germany

Rapid growth and increasing development of the use of diesel engines in Germany may provide particularly cheap engines also suitable for stationary service. Due to the high cost of gasoline in Germany, which is practically all imported, diesels are being used in automobiles, trucks, tractors, etc. About 75 per cent of such vehicles produced in Germany are equipped with diesel engines.

Capacitor Saves $55 a Month

Two months after installation of a 90-kv-a., 4,600-volt capacitor which improved power factor from 72 to 90.7 per cent, Richman Brothers Co. in Cleveland, manufacturer of men's clothing, found it had reduced its power bill $110, an average of $55 a month. At this rate, the saving will pay for the equipment in about 18 months.

This company has a load that averages from 180 to 350 kw. a month at an average power factor of 72 per cent. Power is received in the plant at 4,600 volts and stepped down to 230 volts. By using 4,600-volt capacitors and oil-filled cutouts rather than 230-volt capacitors and oil circuit breakers for connecting the capacitors to the line, the cost of the installation was reduced and a more attractive return on the investment obtained.

COMING MEETINGS

American Society for Testing Materials—Annual meeting, Chalfonte-Haddon Hall, Atlantic City, N. J., June 25-29. C. L. Warwick, 1315 Spruce St., Philadelphia.

American Institute of Electrical Engineers—Northeastern District meeting, Worcester, Mass., May 16-18. Summer Convention, Hot Springs, Va., June 25-29. H. H. Henline, 33 W. 39th St., New York.

Edison Electric Institute—Atlantic City, N. J., June 4-7. B. F. Weadock, 420 Lexington Ave., New York.

National District Heating Association—25th annual convention, Rochester, N. Y., June 12-15. D. L. Gaskill, sec.-treas., Greenville, Ohio.

American Society of Mechanical Engineers—Petroleum Division, Tulsa, Okla., May 14-16. (Also International Petroleum Exposition). Hydraulic Division, University of Calif., June 19-21. Oil & Gas Power Division, Penna. State College, State College, Pa., June 20-23. Applied Mechanics Division at 4th Intntl. Congress of Applied Mechanics, Cambridge, England, July 3-9. Semi-annual meeting of Society, Cosmopolitan Hotel, Denver, Colo., June 25-28. Headquarters—29 W. 39th St., New York, N. Y.

Petroleum Meeting at Tulsa This Month

The A.S.M.E. Petroleum Division will hold its national meeting at Tulsa, Okla., May 14 to 17, in connection with the International Petroleum Exposition. Headquarters will be the Club Room of the Tulsa Hotel. Among the 16 papers to be presented are these of particular interest to power engineers:

Application of Fouling Factors in the Design of Heat Exchangers, E. N. Seider, Foster Wheeler Co.

Heat-Transfer Rates on Condensing, Reboiling and Miscellaneous Heat Exchange Service, Max Higgins, The Texas Co.

Petroleum Fuels and Combustion Data. O. F. Campbell, Sinclair Refining Co.

Air-Gas Compressor Characteristics, J. P. Klep, University of Oklahoma.

Dynamometers for the Study of Pumping Problems, Blaine B. Westcott, Gulf Research Co.

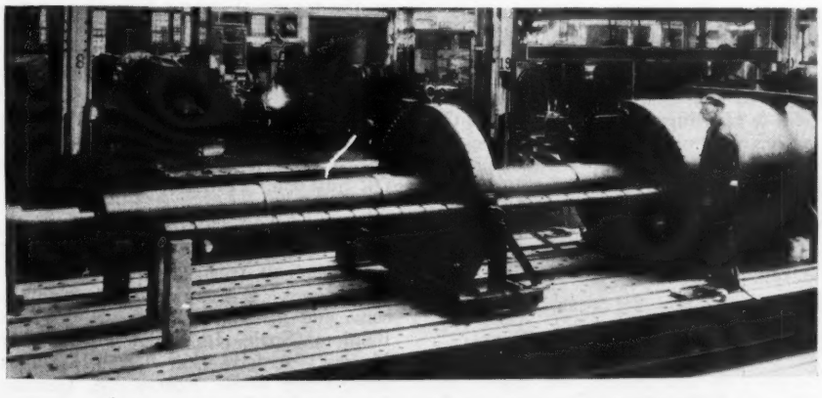
Gas-Electric Prime Movers for Rotary Drilling, D. M. McCargar, Allis-Chalmers Co.

Oil-Field Rotary Pumps and Recent Developments, R. J. S. Piggott, Gulf Research Co.

Selection of Economic Electric Motor Equipment for Pipe-Line Pumping Stations, W. H. Stueve, Oklahoma Gas & Electric Co.

Soap to Condense Steam

Three German and two American engineers have been experimenting with soap as an aid in condensers. They find that copper and brass surfaces are better drop-collectors after being washed



ASSEMBLING TURBINE FOR RICHMOND STREET

A plate being drawn over the huge center bolt of the rotor for Philadelphia Electric Co.'s new 183,333-kva. turbine-generator. Extreme precision is required in placing each plate so that the four 6-in. diameter holding bolts may be inserted by hand. Clearance is only 0.006 in. The center bolt weighs 6 tons, is 13 in. in diameter, 310 in. long and is forged from nickel-molybdenum steel. It is probably the biggest bolt of its kind ever made. Nuts on the four holding bolts will be pulled up by hand as the bolt is stretched ⅜ in. by a 1,500,000-lb. hydraulic pull. The center bolt will be heated by steam through a hole in its center to obtain the same elongation.

The complete rotor will weigh 250,000 lb. The single-cylinder generating set will consist of a 1,800-r.p.m. turbine, as powerful as any yet built, and a 165,000-kw., 3-phase, 60-cycle, 90 per cent p.f., 13,800-volt, double-winding generator. Westinghouse, building the new unit at its East Pittsburgh shops, will have it ready for service late in 1935.

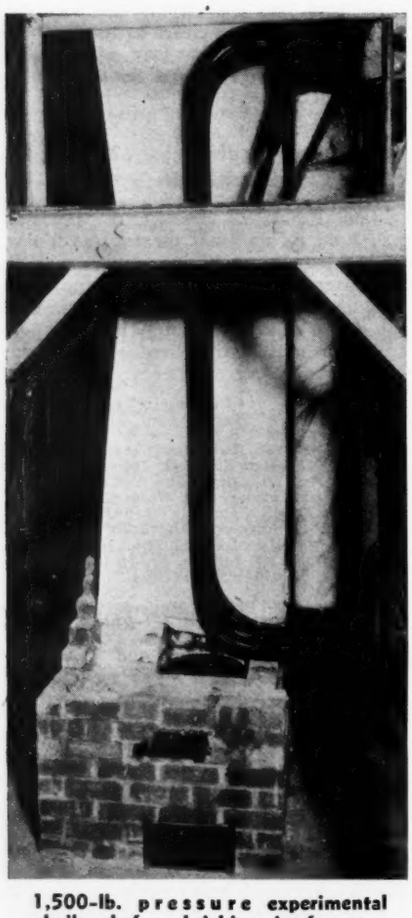
with soap. The active agents turned out to be oleic and stearic acids, the important ingredients of most soaps. A mere trace of either acid on copper, brass, nickel or stainless steel was enough to increase the misting of a surface. Moreover, the acids cannot be easily washed off. Engineers see the possibility of reducing the size of surface condensers by a third to a half.

1,500-Lb. Boiler for Experimental Process Work

An interesting application of high-pressure steam to process, where a sustained high temperature is essential, is to be found in a small 1,500-lb. pressure boiler that a large manufacturer in one of the process industries is now installing for experimental purposes.

The idea underlying the use of saturated steam at this pressure was its ability to supply heat at a constant delivered temperature of 575 deg. F. to the particular process. Obviously, superheat and a lower steam pressure would not have provided a sustained temperature during process, for as heat was given up the superheat would drop. If the experiments with steam from this miniature boiler work out satisfactorily, it is contemplated to install a full-size unit to supply steam at this pressure for regular production. There are undoubtedly processes in other industries wherein this principle could be applied to advantage.

The experimental unit, built by Combustion Engineering Co., consists of a single row of tubes entering top and bottom headers which are connected by a single downcomer. The tubes are 1 in. outside diameter and the headers of forged steel, rectangular in section, placed 7 ft. 2 in. between centers. Total heating surface is slightly over 9 sq.ft., and the furnace will be a simple refractory-lined chamber. The boiler is gas fired, is of the single-pass type and will be hand controlled. Because of its size, experimental use and simple construction, no attempt was made to attain a high efficiency in this unit.



1,500-lb. pressure experimental boiler before bricking in furnace

One-Man Strike

General Candy Co., Milwaukee, Wis., employs one heating engineer. He went on strike March 28 demanding shorter hours. It's a one-man demonstration, but the International Union of Operating Engineers regarded it as a full-fledged strike and negotiated his difficulties.

Spanish Diesels

Development of diesel-engine construction in Spain, begun last year, is advancing rapidly at present, according to reports to the Department of Commerce.

Four diesel engines of the Sulzer type and rated at 1,500 hp. have been turned out by the Sociedad Espanola de Construccion Naval at Sestao and delivered for use in two 8,000-ton vessels of the Spanish Petroleum Monopoly. Maquinista Terrestre y Maritima of Barcelona, has delivered two diesels, Burmeister type, of 975 hp. each for use in a 4,500-ton motor tanker of the Petroleum Monopoly. They are also planning to construct four 2,500-hp. diesels of the Krupp type for delivery to the Compania Transmediterranea.

Bituminous Research

At an informal meeting of a majority of the Committee of Ten of the Coal & Heating Industries, John C. Cosgrove, chairman of the committee, presented a report of the various projects being undertaken by the coal industry, and particularly the continued efforts of bituminous coal people to launch the initial activities of Bituminous Coal Research, Inc.

POWER NOTES

Fourth International Congress for Applied Mechanics will be held at Cambridge, England, July 3 to 9. Subjects to be discussed will be grouped under four general headings: Rational Mechanics, Mechanics of Fluids, Materials and Water Waves. The first heading will include studies on vibrations of structures and machines and the second will discuss turbulence, the boundary layer, heat transfer, and compressible fluids. The Applied Mechanics Division of the A.S.M.E. is cooperating with the committee with the idea of coordinating the participation of other American groups in this Congress. Inquiries should be addressed to Applied Mechanics Division, A.S.M.E., 29 West 39th St., New York, N. Y.

B. C. Electric Railway, Ltd., Vancouver, has ordered through John Redden & Co., Ltd., two motor-driven propeller-type Byron Jackson pumps to lift water from Bridge river into the 13,000-ft. tunnel of the Bridge River-Seton Lake power plant. Each pump will be driven by a 40-hp. G. E. vertical motor.

The recent offer by Meriam Co., 1955 West 112th St., Cleveland, Ohio, to present to engineering colleges "Clean-Out" type manometers for measuring the flow and pressure of gases and liquids has resulted in more than 40 requests for the instrument and a number of requests also for the company's booklet "The Manometer and Its Uses."

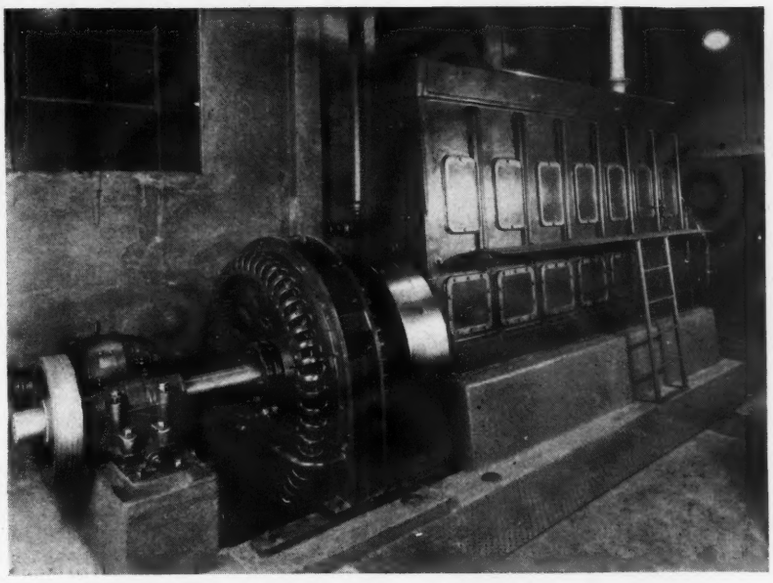
St. Hyacinthe, Que.; will build a diesel power plant estimated to cost about $300,000. Municipal officials have approved plans, awarding a contract to the Montreal Locomotive Works, Ltd., Montreal, Que., for the diesel-engine equipment. These are the first engines of this type built in the Dominion, the order being secured in competition with 28 engine builders in England, France, Belgium, Germany and the United States. Most of the diesels now in service in Canada have been imported from England.

A $15,000,000 irrigation scheme for southern Saskatchewan is proposed. This would include a huge power dam across the southern Saskatchewan River, a mile north of Riverhurst. At this dam, 100,000 hp. would be generated, and at the same time water supplies to Regina and Moosejaw, Sask., provided.

National Motor Bearing Co., Inc., San Francisco, successor to the oil seal business of Cantrell & Miller Mfg. Co., as the result of recent litigation in Chicago, Detroit and Boston, has licensed under the Cantrell-Miller patent the other principal manufacturers in the industry, including: Chicago Rawhide Mfg. Co., Chicago and Detroit; Graton Knight Co., Worcester, Mass.; Super Oil Seal Co., Chicago, Ill.; Universal Oil Seal Co., Pontiac, Mich.

Compagnie des Transporteurs Simplex, 48, Boulevard des Batignolles, Paris, France, has received the agency for "Pneuconex" grit-catching and pneumatic-conveying installations for use in France, Belgium, Spain, Italy and Portugal, and Messrs. Ardeltwerke G.m.b.H., Postschliessfach 86-87, Eberswalde, Germany, for use in Germany, Russia, Holland, Turkey and Central European countries. Rights for the United States of America and South America have not yet been placed, and may be negotiated with W. A. Smith, 172 Buckingham Palace Road, London, S. W. 1, London, England.

Mellon Institute of Industrial Research announces that the fellowship on anthracite, established by Philadelphia & Reading Coal & Iron Co. in 1932, has been continuing, under Dr. H. J. Rose, senior fellow, its program of research.



SOY BEAN MILL POWER PLANT

Ralston Purina Co. of St. Louis has installed this 7-cyl. 9¼x14-in. Buckeye diesel to provide power at its new Lafayette, Ind., soy bean mill. The engine, with direct-connected alternator and V-belt-driven exciter, runs at 400 r.p.m. to deliver 262½ hp.

PERSONALS

Neil P. Bailey, associate professor at the University of North Carolina, has been appointed head and professor of mechanical engineering at Iowa State College, Ames, Ia.

Everett Chapman has been elected vice-president of Lukenweld, Inc., division of Lukens Steel Co., Coatesville, Pa. He joined the company in 1930 as Director of Engineering and Research.

S. P. Foster, district manager of Bird-Archer Co., Chicago, discussed treating and testing of steam boiler feed water at a meeting of the N.A.P.E. and the A.S.M.E. sections in Louisville, Ky., April 20.

F. G. Guthrie and R. L. Gomon, 2842 W. Grand Blvd., Detroit, Mich., will represent Electric Machinery Mfg. Co., Minneapolis, Minn., in that territory.

A. C. Richardson has been appointed to the technical staff of Battelle Memorial Institute. Chester R. Austin has also joined the staff.

C. C. Rosser, formerly district sales manager at Cleveland for Detroit Seamless Steel Tubes Co., has been transferred to Detroit as district sales manager to succeed the late Roy Berryman.

Batt L. Spain, former manager of turbo-blower sales at the General Electric Company's West Lynn works, is now connected with Ingersoll-Rand Co., 11 Broadway, New York, N. Y., as manager of the turbo-blower department.

William F. Sailer, formerly with Alco Products, Inc., and the Griscom-Russell Co., has become connected with Steel and Tubes, Inc. He will be located in the Brooklyn office.

Charles E. Sharp, formerly in charge of the Michigan territory for Mexico Refractories Co., Mexico, Mo., has been appointed general sales manager.

Lloyd R. Leaver, sales manager of the Mechanical Rubber Goods Division of Thermoid Rubber Co., Trenton, N. J., has been elected vice-president of New Jersey Rubber Manufacturing Association.

OBITUARIES

F. Paul Anderson, 67, dean of the College of Engineering at the University of Kentucky, died April 8 after a long illness. He was nationally known for his work in the development of heating and ventilating engineering. He was president of the A.S.H.V.E. in 1927 and a former director of the research laboratory of that society.

Edward W. Jones, 45, vice-president and manager of Laclede Stoker Co., St. Louis, Mo., died March 24 after an illness of three weeks. He was a graduate of the University of Illinois and a member of the A.S.M.E.

Alfred J. Jupp, 58, vice-president of Lunkenheimer Co., Cincinnati, Ohio, died April 10. Mr. Jupp was active in code work in the Valve and Fittings Industry and was a member of the A.S.M.E., A.S.T.M. and S.N.A.M.E.

Dr. Oskar von Miller, 78, founder of the famous Deutsches Museum at Munich, Germany, died there April 9. He was a pioneer in electrical water power engineering and made various study trips abroad.

John T. Shay of Chicago, veteran pump salesman, died suddenly March 29.

BUSINESS NOTES

Darcoid Co., Inc., have moved to new quarters at 200 Varick St., New York, N. Y.

Consulting and Research Ass'n was formed by five former Westinghouse Research Laboratories engineers and offers consulting, research and development service to manufacturing companies. They are located at 823 Franklin Ave., Wilkinsburg, Pa.

Combustion Engineering Corp., Ltd., Montreal, has made several new appointments. Clifford A. Odell was elected vice-president and director; John G. Hall was elected general manager and director; Leonard H. Birkett has been appointed sales manager and F. J. Ellis and Donald S. Abbott, district sales managers.

Superheater Co., New York, N. Y., has appointed the following sales agents for Ljungstrom air preheaters: Combustion Equipment Co., Kansas City, Mo.; F. J. Hearty, San Francisco, Calif.; Walter Castanedo, Inc., New Orleans, La.; J. W. Eshelman, Birmingham, Ala.; J. S. Cothran, Charlotte, N. C.; Rees V. Downs, Memphis, Tenn.; Haylett O'Neill, Houston, Tex.; Joy and Cox, Inc., Denver, Colo. R. E. Chase & Co., Seattle and Tacoma, Wash., have been appointed sales agents for Elesco steam-plant equipment.

Walsh Refractories Corp., 4428 N. First St., St. Louis, Mo., announces purchase of North Missouri Refractories Co. (formerly Missouri Fire Brick Co.) of Vandalia, Mo.

Fred Bathke, 1957 University Place, St. Paul, Minn., and Raymond Church, Box 114, Pleasant Ridge Sta., Cincinnati, Ohio, have been appointed sales representatives for Robins Conveying Belt Co., New York, N. Y.

Air Reduction Sales Co. will be distributor throughout the United States for the brazing alloy, "Sil-Fos," manufactured by Handy & Harman.

Lewis-Chambers Construction Co., Inc., has moved its main office to Solomon Bldg., Helena, Ark.

Maxfield Pease, 4614 Prospect Ave., Cleveland, Ohio, has been appointed representative in northern Ohio for H. O. Swoboda, Inc., succeeding the late E. H. Merrick.

Marr-Galbreath Machinery Co., Pittsburgh, Pa., has moved to new quarters at 55 Water St.

Russell, Burdsall & Ward Bolt & Nut Co., Port Chester, N. Y., has secured the manufacturing and sales rights in the United States of the Marsden locknut. C. E. S. Place, formerly chief engineer of the Marsden Co., now is associated with Russell, Burdsall & Ward in this connection.

Amthor Testing Instrument Co. Inc., are now located at 4-10 Leo Place, Brooklyn, N. Y.

Stephens-Adamson Mfg. Co., Aurora, Ill., has reopened sales engineering offices at 1206 Gulf Bldg., Pittsburgh, Pa., Harry W. Banbury, manager; and Huntington, W. Va., D. W. Allen, manager.

Falk Corp., Milwaukee, announces the appointment of David Adams as sales manager of the Pittsburgh district, with offices in the Grant Bldg.

Timken Roller Bearing Co. has moved its Pittsburgh office to 414 N. Craig St.

600-TON VACUUM-REFRIGERATION UNIT

One of the largest so far built, this steam-jet refrigeration unit is now being installed by Foster Wheeler Corp. at the St. Louis plant of Anheuser-Busch Incorporated to provide cold water for brewery processes. The unit will cool 720 gal. of water per min. from 85 to 65 deg. F.

STRAWS

Pointing the way business winds blow

Westinghouse Electric & Mfg. Co., East Pittsburgh, has been awarded a contract of more than $500,000 for electrical equipment to be installed at Fort Peck Dam on the Missouri River, Montana. The award is for substation equipment, consisting mainly of four 16,667-kva. transformers, three 1,000-kva. transformers, two 20,000-kva. synchronous condensers, a 60-ton crane and other miscellaneous equipment.

Anthony, Kans., has received bids for the following equipment: 750-kw. turbo-generator, 1,600-sq.ft. condenser and auxiliaries, power-plant switchboard, two 51.6-g.p.m., 450-lb. duplex pot-valve feed pumps, and other essential equipment.

Federal Power Commission's study of headwater benefits on the San Joaquin river is making rapid progress. All of the necessary data are now in hand.

The application of Detroit for a loan and grant of $1,500,000 to build its power plant has been received by the Public Works Administrator.

Babcock, Wilcox and Goldie-McCulloch have installed three of their stokers in the new Canadian National Hotel, Vancouver, B. C. These are of the balanced-draft chain-grate type and supply furnaces capable of consuming 4,500 lbs. of coal per hr.

Paragould, Ark., can proceed to build its municipal power plant, having received a favorable decision from the U. S. Circuit Court of Appeals.

Hanna Coal Co., Leader Bldg., Cleveland, Ohio, has awarded a contract to Link-Belt Co., Chicago, for equipment for new 4-track coal tipple at mining properties at Piney Fork, near St. Clairsville, Ohio, with mechanical washing plant, loading facilities, etc. Entire project is reported to cost over $100,000.

Oskaloosa, Iowa, plans early special election to approve bonds for $461,000 for proposed steam-operated electric light and power plant (a recent such election resulted in a tie vote). Plans for station are being completed by Burns & McDonnell Engrg. Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer.

The City Council of Vancouver, B. C., has received power to grant a limited franchise to H. A. Flood and associates for erection of a central heating plant similar to the one operated in Tacoma, Wash.

Cold storage and refrigerating plant, one-story, 50x150 ft., will be built by Border State Grocery Co., Rockdale, Tex., estimated to cost close to $30,000, with equipment. Work scheduled to begin at early date.

J. M. Huber Co., Borger, Tex., recently purchased a 350-hp. rebuilt gas engine from Meriam Co., Cleveland, Ohio, for installation in its carbon-black manufacturing plant. This is the fourth repeat order for these gas engines received from that company.

La Plata, Mo., has approved a bond issue of $25,000, to which it is proposed to add $75,000, secured through Federal aid, making total fund of $100,000 for a new municipal electric light and power plant. Plans are being completed by E. T. Archer & Co., New England Bldg., Kansas City, Mo., consulting engineers. Proposed to use diesel engine generating units. Proposed to ask bids soon.

Culpeper, Va., has ordered two 400-b.hp. and one 240-b.hp. De La Vergne diesel engines for municipal power. These engines, purchased with a Federal allotment, are 15x18½-in. units running at 300 r.p.m., each connected to a Westinghouse 2,300-volt alternator, the first two 268 kw., the third 158 kw.

Republic Distillers, Inc., Cincinnati, Ohio, will install boilers and accessories, pumping equipment, motors, conveyors and other power equipment in its various distilleries. Carl J. Kiefer, Schmidt Bldg., Cincinnati, consulting engineer. Company organized recently to take over and operate former distilling plants in Kentucky and Ohio, and will now carry out a general expansion and betterment program, with installation of new machinery. Plants include Dowling Bros. Distilling Co., Burgin, Ky.; Waterfill & Frazier, Inc., and Ripy Bros., Inc., both of Lawrenceburg, Ky.; H. A. Thierman Co., Inc., Louisville, Ky., and Friedberg & Workum Distillery, Lynchburg, Ohio. Entire project is estimated to cost close to $1,000,000, with equipment.

Health Products Corp., 113 North Thirteenth St., Newark, N. J., plans new boiler plant for factory service, estimated to cost $45,000, with equipment.

White Fuel Corp., 888 East First St., South Boston, Mass., soon takes bids for mechanical coal-handling plant, estimated to cost $75,000. George P. Carver, 62 Dane St., Beverly, Mass., architect.

Hastings, Mich., is considering construction of electric light and power plant, estimated to cost $60,000.

Oroville Cooperative Warehouse, Oroville, Wash., C. J. Koehne sec., has plans under consideration for a cold-storage and refrigerating plant, with capacity for 300 cars at one time. Cost about $100,000, with equipment. Financing to be arranged soon.

Niles, Ohio, has tentative plans under consideration for a new municipal electric light and power plant. Bert Holloway, superintendent of water and light, has made estimates of cost, totaling about $500,000. City Council proposes bond issue.

Several Minnesota power projects are maturing. St. Cloud has plans nearing completion for a new steam-operated electric generating station, estimated to cost $1,249,000, with prime movers and auxiliary equipment; financing through Federal aid. Burns & McDonnell Engrg.

Co., 107 West Linwood Blvd., Kansas City, Mo., consulting engineer; bids at early date. Moorhead is perfecting details for special election and financing for extensions and improvements in municipal power plant, including installation of new boiler, stoker and other equipment; Federal aid has been secured for $28,000, and increase in this amount, as required for program, will be arranged by bond issue; Ralph D. Thomas, 1200 Second Ave., South, Minneapolis, Minn., consulting engineer. Glenwood is securing a fund of $140,000, for proposed new electric light and power plant, for which plans are being completed by Burlingame & Hitchcock, Sexton Bldg., Minneapolis, consulting engineers; it is expected to call for bids for equipment in near future.

State Administrative Board, Lansing, Mich., has authorized plans for a new power plant at the State Girls' Training School, Adrian, Mich., estimated to cost about $70,000, with equipment. Plans also a one-story addition to power plant at the Federal prison at Milan, Mich., to cost about $25,000. Woodworth & Loree, Ann Arbor, Mich., are architects for latter project.

Lodi, Cal., is planning for early construction of a new municipal hydro-electric generating plant on Mokelumne River, estimated to cost $580,000. A report has been made by Nelson A. Eckert and F. C. Herrmann, local consulting engineers. Bond issue of $440,000 proposed, to which will be added a Federal grant of $140,000.

Central steam power plant is planned by Wisconsin Steam Corp., Eau Claire, Wis., care of Buell & Winter Engrg. Co., Security Bldg., Minneapolis, Minn., consulting engineer. Application for permission has been made. New station with pipe lines and service facilities is reported to cost over $100,000.

Hormovita Corp., 543 South Sutter St., Stockton, Cal., plans 1-story boiler and pumping plant in conjunction with new distillery on local site fronting on San Joaquin River. Company was organized recently by Victor Leonardino and associates. Entire program to cost over $225,000. An architect will soon be selected.

Guttenberg, Iowa, has rejected bids recently received for equipment for new municipal electric light and power plant, including two diesel engine generating units and auxiliaries, and proposes to ask new bids early this month. Fund of $70,000 has been arranged. E. Van Vleet, 791 Nevada St., Dubuque, Iowa, consulting engineer.

Imperial Irrigation District, Imperial, Cal., has placed an initial award for equipment for a proposed new generating station on local site, or at Brawley, in immediate vicinity, covering diesel engines and accessories to Hooven, Owens-Rentschler Co., Hamilton, Ohio. The station will be of standby type, to be operated in conjunction with a hydro-electric power plant on the All-American Canal. It is expected to cost close to $400,000, with equipment, and other awards will be made in near future. M. J. Dowd is chief engineer for District.

NEW BULLETINS

Pipe—Johns-Manville, New York, N. Y. 20-page booklet of installations and construction of Transite pressure pipe.

Diesel Engines—Caterpillar Tractor Co., Peoria, Ill. 40-page illustrated bulletin of installations, parts and engineering data.

Machinery—Link-Belt Co., 910 S. Michigan Ave., Chicago, Ill. 1,024-page general catalog containing engineering and dimensional data.

Diesel Engines—Peet & Powers, Inc., 70 East 45th St., New York, N. Y. 16-page booklet of designs and performance data of Lister diesel engines.

Refractory Cement — Quigley Co., 56 West 45th St., New York, N. Y. 4-page Bulletin No. 306 describing "Q-CHROME" refractory cement.

Diesel Engine — Buckeye Machine Co., Lima, Ohio. 32-page illustrated booklet describing design and construction.

Resistance Thermometer—Brown Instrument Co., Philadelphia, Pa. 32-page catalog No. 9001 describing Brown resistance thermometers for temperatures from minus 300 deg. to plus 1,000 deg. F.

Welding—American Manganese Steel Co., Chicago Heights, Ill. Bulletins 1 and 2. Suggestions for welding nickel-manganese steel and hard-surfacing welding rods.

Motors—Sterling Electric Motors, Inc., Los Angeles, Calif. Bulletins No. 130 and No. 133 describing horizontal and upright enclosed vari-speed motors.

Valves — Lunkenheimer Co., Cincinnati, Ohio. 8-page booklet on "Ferrenewo" and "Renewo" plug-type valves.

Welding Fittings—Taylor Forge & Pipe Works, Chicago, Ill. 64-page illustrated catalog on welding fittings and flanges; engineering data and new types of equipment.

Capacitors—General Electric Co., Schenectady, N. Y. 28-page booklet, "Improveing Power-Factor for Profit," with equipment and installations.

Couplings—Falk Corp., Milwaukee, Wis. 4-page bulletin describing Falk-Rawson 4-duty coupling.

Compressors—Worthington Pump & Machinery Corp., Harrison, N. J. Bulletin on horizontal single, belt-driven, direct-connected or steam-driven.

Pumping Units—Pennsylvania Pump & Compressor Co., Easton, Pa. Bulletin No. 223, 12 pages, on Penn-Motor pumping units, including tables on head capacity.

Used Equipment—Acme Equipment Co. Inc., 310 C.P.A. Bldg., Detroit, Mich. Bulletin No. 2000, listings include power-plant equipment available.

Oil Circuit Breakers—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Catalog covering the complete line of oil circuit breakers up to 50,000 kva. Included are tables for selecting proper type of breaker.

Engine Fuel—Philgas Co., General Motors Bldg., Detroit, Mich. Bulletin No. 38 on liquefied petroleum gases as fuel for internal-combustion engines.

Ventilation—Swartwout Co., 18511 Euclid Ave., Cleveland, Ohio. Folder on equipment for ventilation and control of steam, air and water lines.

Electric Heating Units—General Electric Co., Schenectady, N. Y. 50-page booklet on electric heating units and devices, including useful engineering data on power requirements, specific heats, heat losses, etc.

Supervisory Control—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 10-page bulletin describing two-wire visicode and audicode supervisory control, for use in central stations, substations, and oil and gas pipe line operation.

Transmission—Baldwin-Duckworth Chain Corp., Springfield, Mass. Catalog on chain drives, including engineering information for use in design and installation.

Magnetic Timestarters — Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. 2-page circular describing non-reversing magnetic timestarters. Have two points of definite magnetic time limit acceleration on motors of 10-hp. and below and three points of acceleration on 15- and 20-hp.

Elevator Control Cable—A. B. See Elevator Co., Inc., 419 Fourth Ave., New York, N. Y. Folder P-10 illustrates fireproof "Seebestos Cable."

Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. 4-page bulletin on vertical, triplex, single-acting power pumps with multi-V-drive.

Combustion Meters—Hays Corp., Michigan City, Ind. Catalog RA-34 describing CO_2 recorders and indicators, draft gages, etc.

Refractory—Plibrico Jointless Firebrick Co., 1800 Block on Kingsbury St., Chicago, Ill. 32-page illustrated booklet of installations and refractory products.

Reports—American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Bulletin reporting regional meeting held in Washington, meetings during Committee Week, etc.

Turbines—Moore Steam Turbine Corp., Wellsville, N. Y. Bulletin No. 1930-E describing single-stage turbines.

Rheostats—James G. Biddle Co., Philadelphia, Pa. 12-page booklet describing "Jagabi" rheostats, also engineering data.

Air Compressor—Worthington Pump & Machinery Corp., Harrison, N. J. 4-page bulletin, Type VA-2 air compressor units, with ratings, specifications and prices.

Converters—Louis Allis Co., Milwaukee, Wis. Two bulletins, Nos. 509-A and 502-B, describing frequency converters and inverted rotary converters.

Belt Idlers—Chain Belt Co., Milwaukee, Wis. 8-page "Bulk Handling by Belt" shows applications of Rex-Stearns Timken idlers.

Nickel - Chromium Alloys — American Manganese Steel Co., 6600 Ridge Ave., St. Louis, Mo. 6-page folder on types of applications for "Amsco Alloy."

Recording Instruments — Brown Instrument Co., Wayne & Roberts Ave., Philadelphia, Pa. Folder describing the Brown line of recording and control instruments.

FEDERAL ALLOTMENTS

To	For	Loan and/or Grant	Total, Thousand Dollars
Power Plants, etc.			
Valley City, N. D.	Inc. 6,000 sq. ft. boiler	G	17
Waterworks & Pumps			
Wayne, Okla	Inc. pumping equipment	L & G	32
Golconda, Ill.	Waterworks	L & G	66
Great Neck, Long Is., N. Y.	Inc. pumping station	L & G	705
Lexington, Neb.	Waterworks imp.	G	14
Olton, Tex.	Inc. deep well and pumps	L & G	34
Mormangee, Tex.	Waterworks	L & G	32
Hinton, Okla.	Waterworks imp.	L & G	20
Collinsville, Ill.	Inc. pumping station	G	49
St. Edward, Neb.	Add to well and pumps	L & G	5
Lexington, N. C.	Waterworks	L & G	100
Beaver City, Neb.	Waterworks imp.	L & G	16
Magnolia, Miss.	Inc. deep well and pumps	L & G	15
Irvington, Ky	Waterworks	L & G	46
Honea Path, S. C.	Waterworks imp.	L & G	10
Nehawka, Neb.	Waterworks	L & G	21
Livermore, Ky.	Inc. add. pumping equipt.	L & G	35
York, Neb.	Inc. pumping sta.	G	15
West Norriton, Pa.	Inc. pumping sta.	G	60
Stevenson, Ala.	Waterworks imp.	L & G	20
Lynchburg, S. C	Waterworks	L & G	31

NEW BULLETINS

Elevator Accessories—A. B. See Elevator Co., 419 4th Ave., New York, N. Y. 4-page bulletin on Impulse Lubricators. Also 4-page bulletin on Cable Equalizers, including table of tension load in a recent test.

Rotary Pumps—Worthington Pump & Machinery Corp., Harrison, N. J. 2-page leaflet giving uses, features and specifications.

Induction Motors—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Illustrated leaflet describing Type CR, single-phase, repulsion-start, induction motors.

Brewery Power Equipment—Allis-Chalmers Mfg. Co., Milwaukee, Wis. 16-page bulletin, illustrated, of equipment for power, electrical, pumping and other requirements of the brewing industry. Also Bulletin No. 1165, Bracket Bearing Synchronous Motors, with discussion and examples of use of synchronous motors for improvement of power factor.

Balancing Machine—Tinius Olsen Testing Machine Co., Philadelphia, Pa. 4-page bulletin, "Vibro-Electric, Self-Indicating, Static-Dynamic Balancing Machine, Style E-O."

Feed-Water Regulator—Chaplin-Fulton Mfg. Co., Pittsburgh, Pa. 60-page illustrated catalog describing Vigilant feedwater regulator and other steam specialties.

Pyranol—General Electric Co., Schenectady, N. Y. 4-page bulletin on characteristics and some uses of this cooling and insulating medium.

Deep-Well Turbine Pumps—John Bean Mfg. Co., Peerless Pump Division, San Jose, Calif. Illustrated catalog showing construction and typical installations. Also engineering data and reference material for hydraulic problems.

Combustion Testing Outfit—F. W. Dwyer Mfg. Co., 565 W. Washington Blvd., Chicago, Ill. 4-page bulletin on complete combustion testing outfit, containing CO_2 indicator with armored flue-gas thermometer and draft gages.

Mechanical Power Transmission—Mechanical Power Engineering Associates, 634 St. Marks Ave., Brooklyn, N. Y. Well-illustrated booklet discussing and summarizing advantages of modern group drives.

Flow Meter—Brown Instrument Co., Philadelphia, Pa. Folder describing electric flow meter.

Pipe Tools—Borden Co., Warren, Ohio. Catalog No. 34 describing "Beaver" pipe tools.

Ventilation—I L G Electric Ventilating Co., Chicago, Ill. Illustrated bulletin of installations at "Century of Progress," Chicago.

Squirrel-Cage Motors—Louis Allis Co., Milwaukee, Wis. 8-page bulletin on construction, characteristics and uses of different types of motors.

Flue-Gas Scrubber—Riley Stoker Corp., Worcester, Mass. 6-page bulletin illustrating construction and performance of flue-gas scrubber.

Centrifugal Pumps — Morris Machine Works, Baldwinsville, N. Y. Bulletin 152, 20 pages, describes double-suction, horizontally-split centrifugal pumps with helpful hints for installing and operating centrifugal pumps. Common causes of service interruption and remedies.

Valves—Walworth Co., 60 E. 42 St., New York, N. Y. 6-page folder on lubricated plug valves with wedge or double-disk gate-valve face-to-face dimensions.

Boiler-Feed Pumps—Ingersoll-Rand Co., 11 Broadway, New York, N. Y. 6-page bulletin No. 2078 on Cameron multi-stage Type NT pumps for pressures up to 600 lb. Equal number of impellers placed back to back, eliminating high-pressure stuffing boxes.

Bearings—Timken Roller Bearings Co., Canton, Ohio. 266-page loose-leaf book of general information, including various types of bearings, new load ratings, load calculations, bearing selections, dimension sheets, and maintenance.

Gears — Horsburgh & Scott Co., 5114 Hamilton Ave., Cleveland, Ohio. 448-page catalog with excellent engineering data, including horsepower ratings and tooth loads, etc., for gears and speed reducers.

NEW PLANT CONSTRUCTION

McGraw-Hill Business News Department Is Prepared to Furnish a More Complete Daily Service

Ala., Russellville—Municipality, bids about May (if P.W.A. loan is granted), electric power plant. $148,000.

Ariz., Higley—Roosevelt Water Conserv. Dist., plans electric plant for pumping and other domestic uses for district. $386,000. Applied for $386,000 loan under P.W.A.

Ariz., Mesa—Electrical Dist. 5, voted $240,000 bond issue to secure P.W.A. loan for power plant and distribution system for irrigation pumping on 35,000 acres of land.

Calif., Hammonton—Yuba Consolidated Gold Fields Co. plans electric substation. $50,000 or more.

Conn., Wallingford—Borough, A. L. Pierce, Electric Light Dpt., 32 South Elm St., retained Stone & Webster, 49 Federal St., Boston, Mass., to make survey and report on rebuilding hydro-electric power plant, Quinnie Dist., destroyed by fire.

Ia., Guttenburg—City received no bids Apr. 2, constructing municipal light and power plant. $70,000. Voters approved project. May re-advertise.

Ky., Middlesboro—City, I. Ginsburg, mayor, plans Sect. 1, power plant building, garage and stockroom, Sect. 2, complete distribution system, Sect. 3, diesel engine generators and auxiliaries. $328,000. R. Husselman, 310 Hippodrome Bldg., Cleveland, O., engr.

Ky., Fort Thomas—City plans electric light plant and distribution system. $250,000. Awaiting approval of P.W.A. loan and grant. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Ill., Kewanee—City plans light and power plant. $700,000. Applied for P.W.A. loan.

Ill., Springfield—City made plans and soon takes bids power plant, switchboard, motors and miscellaneous equipment. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Mass., Falmouth—Town, N. M. Gediman, chn. Electric Light Comn., sketches municipal lighting plant. Metcalf & Eddy, 1300 Statler Bldg., Boston, engrs.

Mich., Gladstone—Municipality retained Shoecraft, Drury & McNamee, engrs., Ann Arbor, to prepare plans and estimates for an electric lighting plant. $75,000.

Mich., Kalamazoo—The Upjohn Co. plans 10 story factory and office building for pharmaceutical company, also power plant. $200,000.

Miss., Meridian — City plans power plant. Awaiting approval from P.W.A. for loan and grant. Burns & McDonnell Eng. Co., 107 West Linwood Blvd., Kansas City, Mo., engrs.

Mo., LaPlata—City voted $75,000 for municipal light and power plant. Application for $25,094 grant and $74,906 loan under P.W.A. pending in Washington. E. T. Archer & Co., 609 New England Bank Bldg., Kansas City, consult. engrs.

N. Y., Cananadaigua—L. C. Reynolds, Geneva, engr., made sketches municipal light and power plant and distribution system. $260,000.

N. Y., Mamaroneck — Committee, c/o H. Hornidge, mayor, plans hydro electric project to utilize falls and dams of waterworks system. Maturity indefinite. Engineer not appointed.

N. Y., Ocean Beach—Municipality plans electric power plant. $135,000 loan applied for under P.W.A. Architect not appointed.

N. Y., Rochester—Village bids in May, two 700 g.p.m. Layne type wells, one 500,000 gal. elevated storage tank, softener equipment, two 700 g.p.m. turbine well pumps, 5,905 lin.ft. 6- to 8-in. c.i. pipe, 25 small pump houses, etc. $80,000. R. G. McDonald, 308 Main St., East Rochester, engr.

N. C., Belhaven—Town, R. Gibbs, mayor, filed application with P.W.A. loan to finance construction power plant. $50,000. Application forwarded to Washington.

N. D., Valley City—City plans municipal heating plant. $58,000. $17,000 P.W.A. grant.

O., East Cleveland—City, C. A. Carran, mgr., 1434 Euclid Ave., making surveys to determine cost of construction municipal light plant. $1,500,000. R. Husselman, 310 Hippodrome Bldg., Cleveland, engr.

O., Middle Point—City made application for P.W.A. loan and grant of $35,907 to finance 100,000 gal. steel storage tank, iron pipe, distribution system, constructing pump house and develop supply well, electrically driven turbine pump. C. J. Simon, engr. of Van Wert, prepared preliminary plans.

O., Minerva—Village Council, Bd. P. Affairs, soon takes bids new machinery and equipment for installation in municipal electric light plant. $25,000.

Okla., Chandler—City plans electric light plant. $142,000. P.W.A. loan and grant approved. Benham Eng. Co., Perrine Bldg., Oklahoma City, engrs.

Okla., Woodward—City plans municipal light and power plant. $290,000. Application for P.W.A. loan and grant approved by State Advisory Comn.

Pa., Chambersburg — Borough appropriated $59,000 to purchase 2,500 kw. generator; $895 for generator air cooler, $10,680 for condenser; foregoing as improvements to light plant. Albert C. Wood Co., Stock Exchange Bldg., Phila., engrs.

Tex., Matador—City voted $8,000 waterworks pipe extensions and pumping equipment. Montgomery & Ward, Harvey-Snider Bldg., Wichita Falls, engrs.

Utah, Hatch—City plans waterworks and power plant. Applied for $29,451 P.W.A. loan.

Washington—U. S. Bu. Reclamation, will open bids June 18, at office Columbia Basin Commission, Spokane, construction Grand Coulee dam and power plant near Almira, about 100 mi. west of Spokane. R. F. Walter, Custom House, Denver, Colo., ch. engr. F. A. Banks, Almira, engr. charge.

W. Va., Moundsville—City making surveys municipal electric light and power plant. P. J. Luftus, Oliver Bldg., Pittsburgh, Pa., advisory engr.

Wyo., Albin—City plans municipal power and light plant. $30,000. Applied for loan under P.W.A.

Alta., Edmonton—City prepared plans power plant extension, incl. building, $156,500; two boilers and boiler equipment, $310,600; one 15,000 kw. turbo-generator with condenser and auxiliaries, foundation and erection, $326,500; circulating water system, $35,500; evaporators, heaters and feed pump, $46,500; electrical equipment, $21,000; lighting, heating, ventilating and drainage, $17,500; steam, water and other piping, $85,000; engine room, $27,000; tools and equipment, $2,300. Total est. $1,200,000.

Alta., Rimbey — Municipality plans power plant with dam at Blindsman River, dynamo, turbine, etc., and transmission lines.

B. C., Vancouver—H. A. Flood & Associates, Tacoma, Wash., have been granted franchise by City, to construct central heating plant to serve Wards 1 and 2. Est. $250,000.

Ont., Chapleau—Town, T. R. Serre, twp. clk., council considering installation of new light and power system. $25,000 for plant and $10,000 for distribution system.

Ont., Forest Hill—Town Council plans hydro-electric plant. D. G. S. Huland, Reeve.

Ont., Sioux Lookout—Ontario Hydro-Power Comn., 620 University Ave., Toronto, plans 1,000 hp. hydro-electric generator plant and dam. $300,000. G. H. Bradshaw and J. R. Montague, engrs.

Australia—Town Council, East Perth, voted $2,500,000 for extending power station.

Union Socialist Soviet Republic—Soviet Government, Moscow, or c/o Amtorg Trading Corp., 261 5th Ave., New York, dam and hydro-electric project at Kherson at junction of Ingules and Dnieper rivers, increasing navigability of rivers, provide electric power, and irrigate left bank of Dnieper River by technical aid contracts. To exceed $20,000,000.